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Farmer's cyclopedia of agriculture

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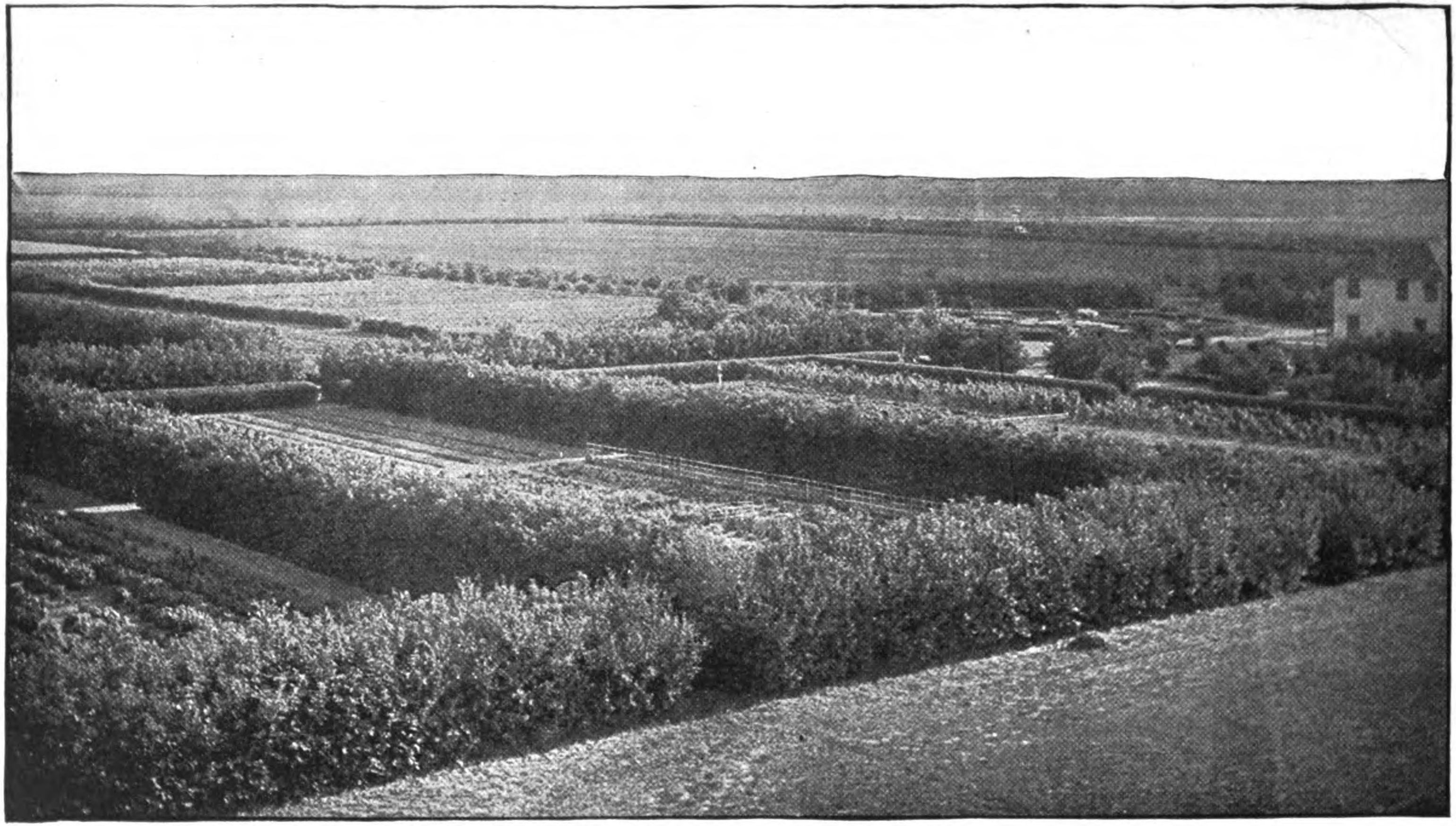

WINDBREAKS FOR PROTECTING SMALL FRUITS AND VEGETABLES
Canada Experimental Farm, Northwest Territory

Farmer's
Cyclopedia of Agriculture

A COMPENDIUM OF AGRICULTURAL SCIENCE AND
PRACTICE ON FIELD, ORCHARD, AND GARDEN
CROPS, SPRAYING, SOILS, THE FEEDING AND DISEASES OF FARM ANIMALS, DAIRY FARMING, AND
POULTRY IN THE UNITED STATES AND CANADA

By

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United States Department of Agriculture, Washington, D. C.

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PREFACE

The present volume is written for actual and prospective farmers in the hope that it may be of service in the advancement of agriculture. It contains an account of the best methods of planting, cultivating, harvesting and utilizing the important farm crops, including field crops, fruits and garden vegetables; and a discussion of all the important data concerning the care and feeding of farm animals, including poultry. The more serious diseases of animals and enemies of crops are described and practical remedies suggested. Various general farm subjects, such as fertilizers, manures, soils, silage, irrigation, spraying, etc.. are also discussed.

The authors have made a special effort to call the attention of farmers to the vast amount of valuable literature along agricultural lines, published by the various State Experiment Stations and the United States Department of Agriculture. In referring to experiment station work credit has usually been given to the station rather than to individuals, since in most cases the final results cover the work of several years, during which time many different individuals worked on the details. The idea has been to draw attention to the institution, which is permanent, rather than to the individual, who is likely to change his residence from year to year.

The book was originally arranged alphabetically. At the suggestion of the publishers, however, it was decided to arrange it in chapters for the greater convenience of those who may be interested in but one phase of farming, and for the further reason that a more complete index may thus be made than by any other method. The rearrangement has made it necessary to group certain subjects in a miscellaneous chapter. Within the chapters the alphabetical order has been largely followed. Diseases and insect pests are discussed under the plant or animal which they most seriously affect.

The mass of agricultural literature is enormous and rapidly increasing. It requires more than a thousand pages annually to give brief abstracts of the more important articles. This mass of literature, however, is not available to the farmer. He has no time to wander about in the wilderness of details nor to attempt to harmonize apparent contradictions. The farmer is interested in results rather than methods of arriving at them. The authors believe, therefore, that the necessity of a digest of the results obtained by farmers and experimenters is evident. The authors have not hesitated to draw such conclusions as are warranted by the experiments, believing that point is thus given to the bewildering details of the literature.

In preparing this volume the authors have made use of the publications of the American Experiment Stations, United States Department of Agriculture, and farm papers, as well as the published results of work in foreign experiment stations and personal experience. The work involved in the preparation of this volume has been about equally divided between the authors. The cultural details of all the plants were prepared by Mr. Smith. Dr. Wilcox is responsible for the discussion of fungous diseases and insect pests of these plants. Dr. Wilcox is also responsible for all articles on the feeding and diseases of farm animals (including poultry) except that on sheep.

We wish to acknowledge our indebtedness for the use of illustrations which were kindly loaned by the United States Department of Agriculture, the Experiment Stations located in the following States: —Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Indiana, Iowa, Kentucky, Maine, Minnesota, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Rhode Island, Tennessee, Utah, Wisconsin and Wyoming; and also by S. B. Green of Minneapolis, James Mills of the Ontario Agricultural College, William Saunders of the Canada Experiment Farms, E. P. Felt of Albany, N. Y., the *American Agriculturist,* the *Breeder's Gazette* and S. J. Hunter of the University of Kansas.

We desire to express our gratitude for the courtesies shown us by the publishers and for the interest manifested by them, and especially by Dr. F. M. Hexamer, in securing illustrations.

Washington, D. C., 1904.

THE AUTHORS.

FARMER'S
CYCLOPEDIA OF AGRICULTURE

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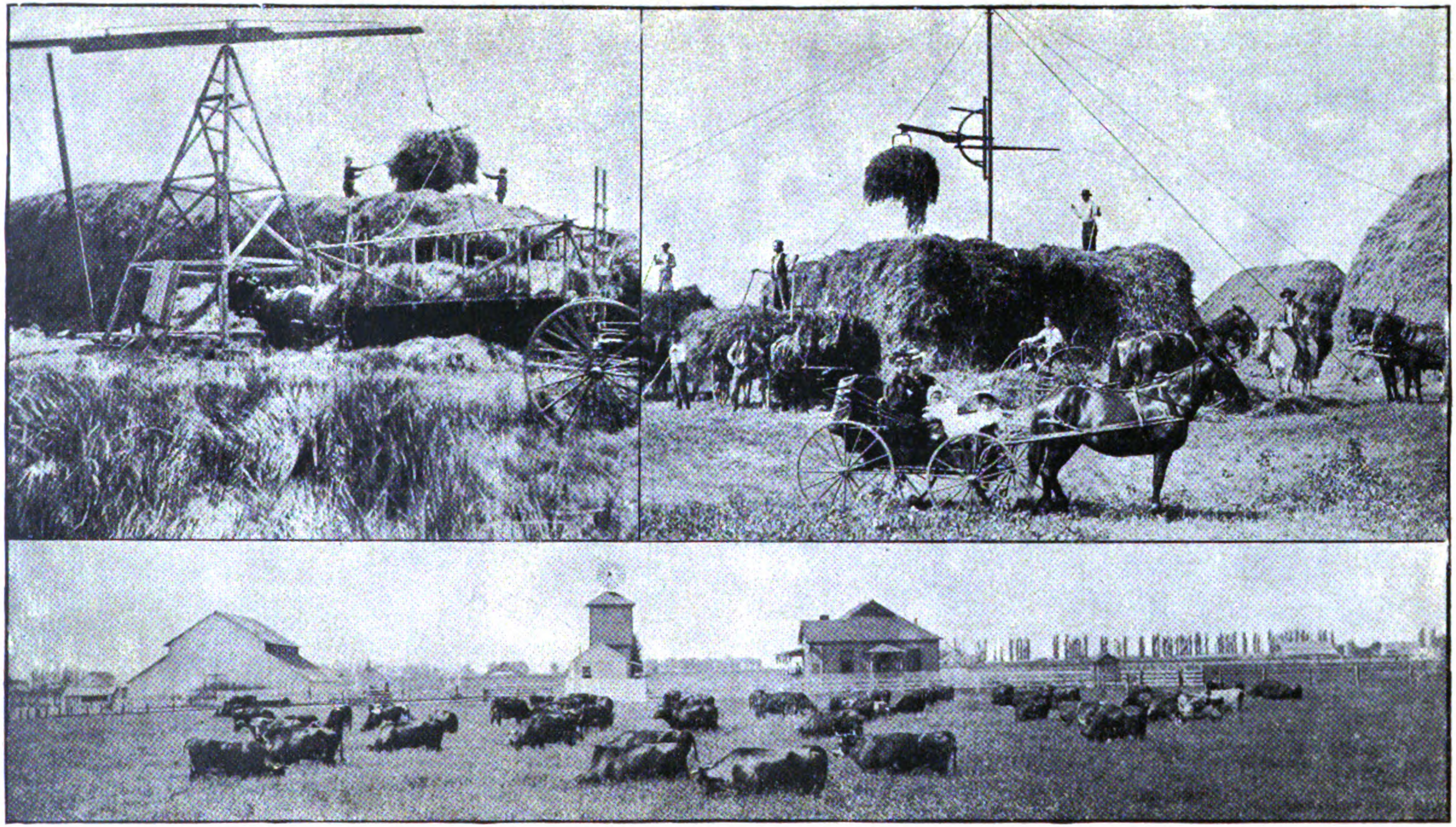
PART I

FIELD CROPS



ALFALFA—ONE OF THE MOST REMARKABLE OF AMERICAN FORAGE CROPS
Upper left hand picture shows details of derrick stacker and fork as used in the Northwest. Right hand photograph illustrates stacking alfalfa in Norton county, Kansas. The lower illustration shows remarkable profusion of alfalfa pasturage in Stanislaus county, California

FARMER'S CYCLOPEDIA OF AGRICULTURE

FIELD CROPS

ALFALFA, or Lucern (*Medicago sativa*)

One of the most valuable leguminous hay and forage crops cultivated in the United States. It has been grown experimentally in every State and Territory of the United States, and while valuable in all, it finds especially congenial conditions in the Western and Pacific States, where it is grown to the practical exclusion of all other forage crops. It is a clover-like plant with a single tap root, averaging in sandy soils less than ¾ of an inch at the crown and extending perpendicularly downward from 8 to 12 feet and sometimes 30 to 40 feet or more. It grows to a hight of from 2 to 5 feet. It is not superior to red clover as a forage crop in most of the Northern and Northeastern States, except where the clover-root borer prevents the culture of the latter, and it is more difficult to establish. In the Central and Middle Eastern States it is rapidly increasing in popularity. Under Western conditions of light rainfall and irrigation it is the most valuable forage crop that can be grown. A single alfalfa plant is shown in Fig. 3, and an alfalfa field in New Jersey is seen in Fig. 4.

Alfalfa will grow on nearly all good well-drained soils, but it thrives best in a rich, sandy loam, with a permeable subsoil, and will not live beyond a year or so in cold, heavy clays and wet lands. The crop develops most rapidly under irrigation, but water must not be allowed to stand on the plants over 48 hours, or they will be smothered and the roots rot. On calcareous soils alfalfa does especially well.

Land intended for alfalfa must be thoroughly prepared by deep plowing and should be practically free from weeds. The first year is largely spent in establishing the plants, and full crops are not secured until after the second or third year. Once established, however, the field will continue to yield paying crops for years. Some fields in the West have been cropped continuously for 30 years or more, and are still in good condition.

Seeding—In the Northern and Eastern States, alfalfa should be sown in the spring after danger from heavy frost is past. It should not be seeded with wheat or oats, as is usual with clover, but sown alone. If sown broadcast, from 20 to 25 pounds of seed will be required per acre; if drilled, 15 to 20 pounds. The seeds should be lightly harrowed in across the drill rows. The larger amount of seed is best if a good quality of hay is wanted, while a lesser amount, 15 pounds, is about right if the crop is grown for seed. It is a waste of time to attempt to grow the crop on weedy ground, as the young plant is very tender and easily

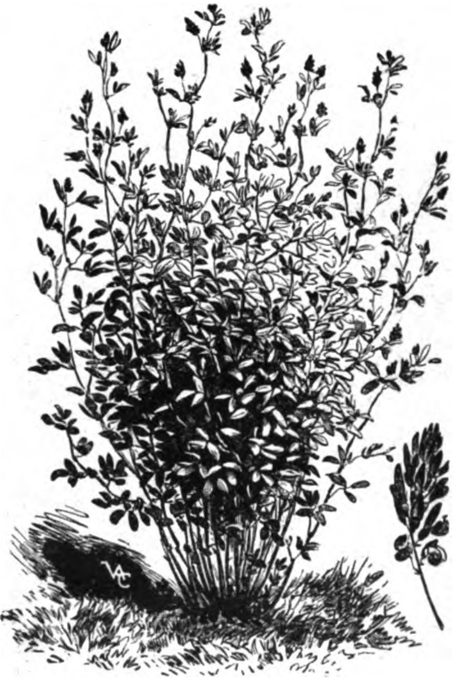


Fig. 3—ALFALFA PLANT AND FLOWER

smothered out by the rank weeds. If the plants grow rapidly a light crop of hay may be cut the first season. In any case, the fields should be mowed high, once or twice, to control weeds and prevent any from going to seed. Young plants must not be cut too late in the fall of the first year. If allowed to form at least 5 or 6 leaves before cold weather sets in, they will withstand the rigors of winter much better.

Alfalfa in the South succeeds best if grown after some hoed crop, and when planted either in September or February. Broadcasting is not advisable because of the abundance of crab grass, foxtail and other weeds. Better results are secured by seeding 20 to 25 pounds per acre in drills 16 inches to 2 feet apart, and keeping the rows cultivated the first season.

In the Rocky Mountain States, up to elevations of 7000 feet, the seed may be sown as soon as settled weather comes on in the spring. Where the rainfall is light, the ground should be irrigated as soon as it is plowed and harrowed, and just before the seed is sown. About 30 pounds of seed per acre, lightly cultivated in, has proved most satisfactory. In California and the Southwest, seed may be sown any time from August to the middle of December, and from February to April. Spring seedings are usually made with oats or wheat, and after the grain is cut 1 or 2 crops of hay can be secured the first season. A more certain stand is secured if the alfalfa is seeded without a nurse crop.

Harvesting—Alfalfa is cut for hay just as the first flowers are coming into bloom. At this time it is tenderest, contains the greatest amount of valuable food material (see *Table of Analyses, Appendix*), and makes the best hay. It should be cut in the forenoon, spread out with a tedder, and allowed to cure until the leaves are well wilted, then raked into windrows, as with clover, and after a little further drying be removed directly to the stack or barn. The less it is handled, the better, as the leaves, which are the most valuable part of the plant, easily rattle off if too dry. On the other hand, if the hay is put up too green it will heat and lose much of its feeding value. The curing of alfalfa, like clover, must be learned by expe-

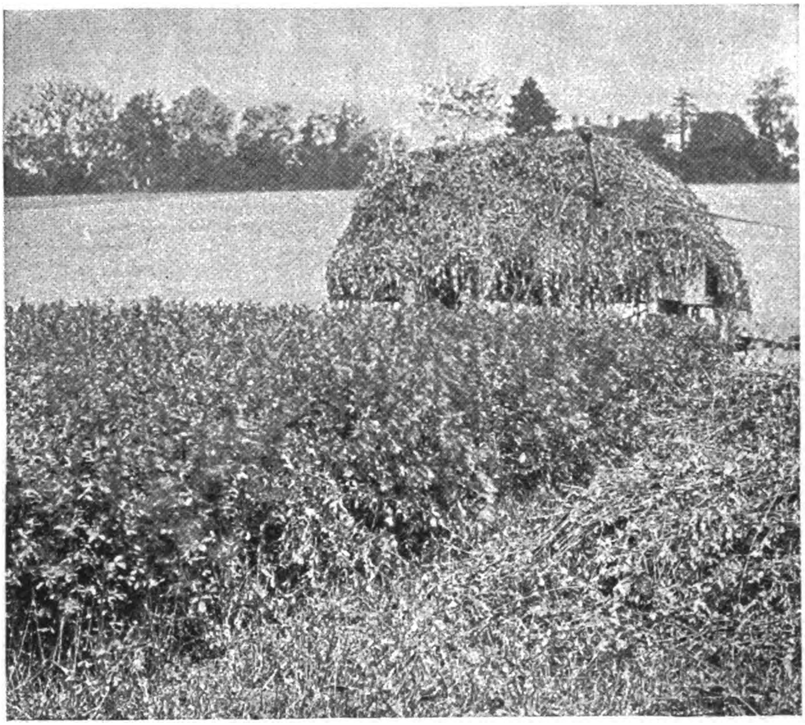


Fig. 4—ALFALFA FIELD IN NEW JERSEY

rience, and specific directions cannot be given.

The number of times alfalfa can be cut after it is established, varies from 2 to 3 times in the East to 6 or 8 cuttings in California. The yield will vary from 3 to 8 or more tons of cured hay per acre for the whole season. Where irrigation is practiced, the water should be turned on immediately after each cutting.

Seed—In growing alfalfa for seed in the East, the second crop is best because better filled. In Colorado, the first crop is considered most desirable. The crop for seed should be cut when the pods are dark brown, and no rain should be allowed to fall upon it. Many Kansas, Nebraska and Colorado growers cut seed alfalfa with a binder, and claim it is more easily handled in this way. An average seed yield is from 5 to 10 bushels per acre. Alfalfa flowers are so arranged that they must be cross fertilized in order to produce seed. Insects are essential in this connection, and honey bees are especially valuable. Where they are abundantly present the yield of alfalfa seed is about doubled. Alfalfa is considered by bee men one of the best honey plants grown.

Feeding Value—Alfalfa is rich in protein elements, which are converted by animals into blood, muscle and bone, and when fed with corn, roots, oat straw, corn fodder, etc.—foods poor in protein, but containing large proportions of fat-making elements—forms a most desirable ration for all farm stock. For growing cattle, horses and sheep there is nothing better than alfalfa hay, and pork cannot be made cheaper than by allowing the hogs to run on alfalfa pasture.

Alfalfa will not stand heavy pasturing and care must be observed in its use. Cattle and sheep are liable to bloat if pastured on young alfalfa, or when it is wet with dew, but with hogs and horses there is no danger whatever. For a detailed account of the feeding value of alfalfa see under each of the different farm animals.

Alfalfa is good for the land. Like other legumes, it has the power of gathering nitrogen, one of the essential plant foods, from the air. (See *Leguminous Plants.*) Its deep-reaching roots bring up fertilizing elements from the subsoil and place them where they may be utilized for other crops. When plowed under, its leaves, stubble and roots add much humus and nitrogen to the soil and leave it in a most excellent condition for all other farm crops. It is very little troubled with insects or diseases.

Turkestan Alfalfa (*Medicago sativa Turkestanica*) is a hardy variety, introduced from Russian Turkestan. The results of experiments with this crop indicate that for the region west of the Mississippi River and north of Kansas and California, this variety is hardier and more productive than that commonly grown in that region. It seems to endure drouth better and is not as easily affected by freezing, and gives better results on strongly alkaline soils. In the East and South, however, it does not compare favorably with the ordinary alfalfa. It is claimed for this variety that its stems are smaller and it makes more nutritious hay than common alfalfa, and in the Northwest the experimental data indicate that it is more productive both with and without irrigation, than ordinary alfalfa.

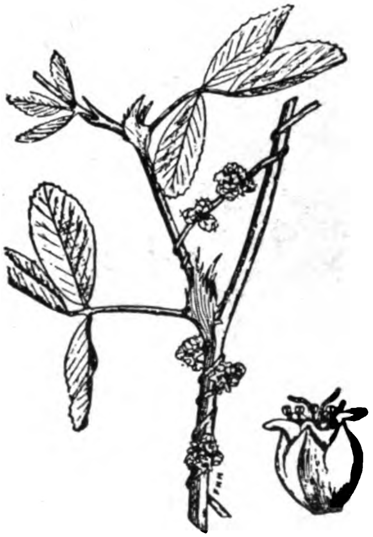


Fig. 5—DODDER PLANT AND FLOWER

Other Varieties—There are 2 other species of alfalfa, *Medicago media,* and the yellow lucern, *M. falcata,* neither of which has much agricultural value in this country. The species *Medicago media* has been very successfully grown under the name of *Sand lucern* at the Michigan Station, and a discussion of the plant is given under that heading. (See *Sand Lucern.*)

Literature—The U. S. Dept. of Agr. has published a valuable Farmer's bulletin on alfalfa, No. 31. See also Colo. Expt. Sta. Bul. 35; Ill. Expt. Sta. Bul. 76; Md. Expt. Sta. Bul. 85; Minn. Expt. Sta. Bul. 80; N. J. Expt. Sta. Bul. 148; Kan. Expt. Sta. Buls. 90, 104, 114; Utah Expt. Sta. Buls. 48, 58 and 61; and F. D. Coburn's work on alfalfa.

Enemies: ROOT ROT (*Ozonium auricomum*) attacks a great variety of plants, including alfalfa, cotton, apple, peach, apricot and other trees. It attacks alfalfa near the surface of the ground and extends downward, ultimately killing the plants. The decaying roots are surrounded by a mesh of brown strands. The mature stage of the fungus is not known. The disease spreads in all directions through the soil and it is therefore recommended that a trench be dug around the centers of infection. Some writers urge the application of salt or kerosene to infested soil in order to kill the fungus. Rotation of crops is the most successful remedy, and grasses should be used as the alternating crop, since they are not attacked by the fungus.

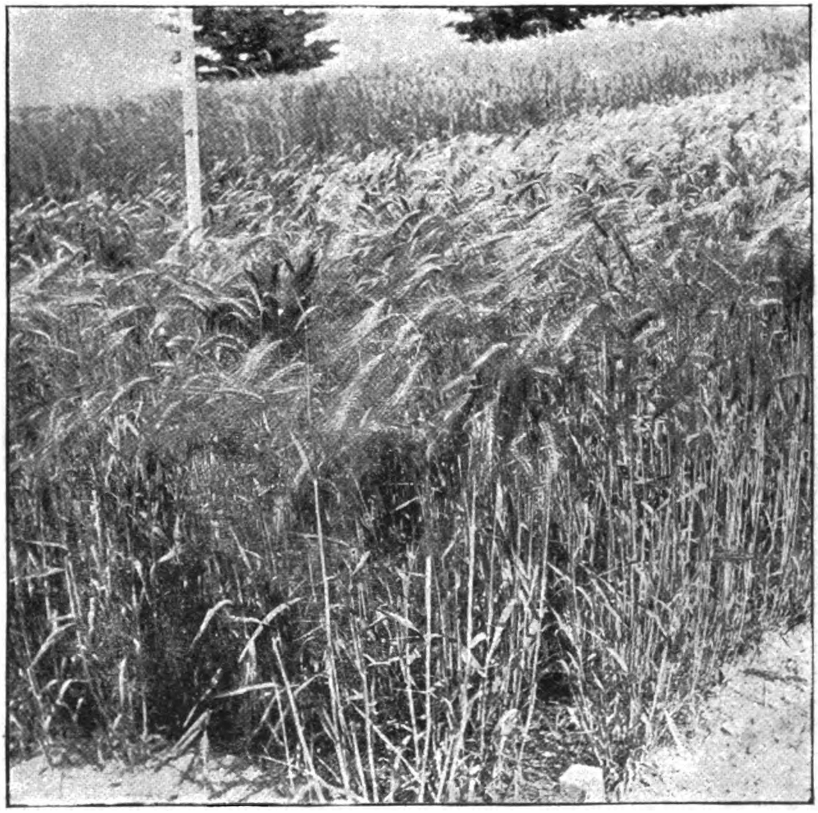


Fig. 6—FIELD OF WINTER BARLEY
(Tennessee Station)

LEAF SPOT (*Pseudopeziza medicaginis*) is the most destructive disease of alfalfa, and occurs in almost every locality where alfalfa is cultivated. The plants are usually attacked after the first year's growth. Irregular brown spots appear on the upper surface of the leaves, and later the spots contain black centers. The disease spreads by spores floating in the air. Frequent cutting of the crop sometimes prevents the distribution of leaf spot. New fields of alfalfa should be planted as far as possible from infested fields. The disease survives the winter and may remain in the same field for many years. The fields may be burned over each fall in order to destroy diseased leaves.

Several species of cutworms feed on alfalfa and at times occur in such numbers as to cause serious loss. They may be dealt with as recommended under *Onions*. Alfalfa is also attacked at times by the *Army worm, Locusts* and *Leaf hoppers*.

DODDER (*Cuscuta epithymum* and *C. trifolii*) are parasitic plants which frequently infest alfalfa fields, particularly in the West. The stems of these plants are leafless yellow-like threads, which twine around the alfalfa stem and rob it of its juices by means of sucking roots. The dodder spreads very rapidly, forming tangled masses, and soon completely chokes out the alfalfa. Small infested areas should be mowed before the dodder blossoms, covered with straw and burned where it lies. Where whole fields are affected, they should be plowed and planted to some cultivated crop for a year or so. As the plant is an annual, it will die out in 1 year if not allowed to go to seed. The usual method of introduction of this pest through alfalfa seed can be prevented by thorough screening, since dodder seed is only about one-half as large as alfalfa seed and can be screened out. In no case should alfalfa seed from an infested field be planted. A dodder plant and flower are seen in Fig. 5.

BARLEY (*Hordeum* spp.)

This grain is grown in America primarily for 2 purposes: Malting and stock feeding. Limited amounts are also used for human food, more especially when prepared in the form of pearl barley and used in soups. The experimental work with barley in the United States has been confined more particularly to its growth as a stock food, though the bulk of the crop produced in the country is used for malting. The crop is grown in all the Southern States and far north into Canada. Experimental data from Colorado show that it will mature in that State up to elevations of 7000 feet. Although barley is easily grown in nearly all sections of the country, for various reasons its extensive culture is confined to a few States. A field of winter barley grown in Tennessee is seen in Fig. 6.

California is the principal State of production, followed by Minnesota, Wisconsin, North Dakota, Iowa and South Dakota. The average yield for the whole country is about 25.5 bushels per acre, and the average price per bushel in 1902, 50 cents.

Soil—The best barley for malting purposes is grown on a rather light, dry, friable soil containing lime and resting on a naturally drained subsoil. Heavier yields of grain and straw, however, are obtained on fertile clays and clay loams. Malting barley generally brings the highest price in the market, and this increased price may average up for the lower yields, but for feeding purposes a grain of much higher feeding value can be grown on the heavier, richer soils. The Colorado Station recommends an open warm soil tending to clay rather than sand, with good drainage and not much alkali.

Seedbed—The seedbed for barley should be plowed fairly deep and thoroughly pulverized. A field which has been into some hoed crop well fertilized with barnyard manure makes a good preparation for barley. Excellent results have also been secured in the West after a crop of alfalfa. Thorough preparation of the seedbed is essential in barley culture and is much more important than with wheat or any other grain crop. The reasons for this may be briefly stated: The growing season of the plant is short; the crop is usually sown in the spring and ripens on an average within 100 days. In order that this rapid growth may take place, the soil must be in a condition to permit the easy formation of roots—permeable, warm, and rich in all the elements of plant food in the upper tilled portions; for the plant is essentially a surface feeder.

Seeding—In the Northern States barley is sown after spring wheat is put in and just before oats. Although the crop is grown in sections much farther north than wheat, the young plants are more sensitive to frost and are easily injured by other untoward weather conditions, such as drouth, a long spell of cold rain, etc. In Georgia and a number of other Southern States, where barley is grown almost exclusively for pasturing and soiling, it may be sown in September and on rich soils as late as October. Even as far north as Maryland the Agricultural Experiment Station recommends that both winter and spring barley, when grown for either pasture or grain, be sown about the first of September rather than later. When sown at this time on strong land it makes a valuable fall and spring pasture. In this connection the same station notes that one of the best barley crops grown in the vicinity of the station (55 bushels per acre) was pastured most of the winter with sheep. Another crop which yielded well was pastured hard both fall and spring. In

California barley may be sown at any favorable time during the winter and up to the end of March.

The results of a number of experiments have shown that on soils of medium fertility seeding at the rate of about 8 pecks per acre is about right. On richer soils or when broadcasted, 10 pecks may be sown.

In a test at the North Dakota Station of sowing barley at depths varying from 1 to 4½ inches, the heaviest yield of grain was obtained from seedings 3 inches deep. In Minnesota the heaviest grain yield was obtained from seedings 3½ inches deep. As a rule to follow, seeding 3 inches deep is about right.

Fertilizing—In the fertilizing of barley the purposes of the crop—whether for stock food or for malting—must be considered, since the composition of the grain is much influenced by the fertilizers employed, and grain best for stock feeding is poorest for malting. For malting purposes barley rich in starch and poor in protein is wanted, while for feeding, grain having a rich protein content is of greatest value. Very rich soils or soils heavily fertilized with barnyard or other nitrogenous manures tend to the production of a rank growth of straw and a grain rich in protein, and hence on such soils grain for stock feeding should be grown. On light soils many European investigations have shown that the addition of fertilizers containing relatively large amounts of potash is productive of a heavy grain rich in starch and poor in protein—a grain well suited for malting purposes. Phosphatic fertilizers have a similar effect on the grain. Within recent years more and more barley is being grown for feeding. Where this is the object in view, the best fertilizers, as for all the cereals, are those well supplied with nitrogen and phosphoric acid, hence the value of superphosphate, ground bone. and top-dressings of nitrate of soda for barley.

In fertilizer experiments extending over a period of 12 years at the Canada Experimental Farms, the use of 300 pounds of common salt per acre, per year, without other fertilizers, has given better average yields than any of a number of combinations of fertilizers. This result is remarkable, since salt is not a direct fertilizer at all, and for most crops is used without any benefit whatever.

Rotation—Barley is the second crop in the celebrated Norfolk Rotation (common in England). This rotation is for light soils and begins with turnips the first year pastured off by sheep, barley the second year, clover the third, and wheat the fourth. The fifth year turnips come in again and the rotation is repeated. It is believed that this system of rotation might be profitably followed on many of our lighter sandy soils. If the whole farm is divided into 4 fields, by this system of rotation half the farm will be producing grain crops each year and the other half fodder crops for feeding. Corn or peas might be substituted for the roots if thought desirable.

Harvesting—Barley should be harvested when the grain is ripe, but not dead ripe. The price of barley for brewing purposes is largely governed by the color of the grain, and this is influenced by the period of ripeness. The brighter the color the higher the price paid. At the Maryland Agricultural Experiment Station barley was cut at 3 different stages of ripeness and the effect on the color of the grain noted. The first cutting was made when the straw was mostly ripe and the grain nearly all in the dough stage; the second, 2 days later, when the straw was ripe and the grain all in the dough stage; and the third, 2 days later than the second, when the straw was entirely ripe and the grain quite hard. Upon threshing it was found that the grain cut last was the darkest, that cut first next in shade, while the brightest in color was that cut intermediate between these two. The long beards on most barleys make it desirable to cut the grain with a binder whenever possible. Care should be taken that no dew or rain fall on the barley after it is cut, since this discolors the grain. It is largely owing to the absence of rain or dew that the brightest barleys are produced in the West, where irrigation is practiced. For hay barley should be cut in the early milk stage.

Varieties—Barleys may be divided into 2 classes: The hulled, and the hulless, "naked" or "bald" barley. Of the hulled barleys there are 2-rowed (*Hordeum distichon*), 4-rowed (*H. vulgare*), and 6-rowed (*H. hexastichon*) types. The 2-rowed type is generally considered the best malting barley, while the 6-rowed is the type usually grown for feeding. Results of 5 years' tests at 5 Canadian Experiment Stations place Chevalier, Beaver, Canadian, Thorpe, Newton and Sidney at the head of the list of 2-rowed varieties grown; while the heaviest yielding 6-rowed varieties at the same stations were Manshury, Trooper, Odessa and Common. In Colorado Chevalier was by far the best malting barley grown, while California has given the largest yields and is believed by the station to be the best in that State for sheep feeding. Manshury has given the best results at the Iowa and Wisconsin Stations.

The hulless barley (*H. distichon nudum*) is grown only for feed. The principal varieties are either black or white. At the Colorado Station the white varieties have usually produced better than the black. Hulless varieties are usually not as productive as the hulled, but a variety known as "Success" has gained a good reputation as a profitable crop in the foothills and mountain parks of Colorado. The station states that at 7000 feet it produces a crop of grain and that up to 8500 feet it will make a heavy crop of hay, if cut just after blossoming, that takes the place of both hay and grain. The variety Success has given an average yield of 45 bushels per acre at the Iowa Station and is thought especially well of as a nurse crop. On the plains, however, the hulled varieties make the best yields. The hulless varieties are generally earlier than the hulled sorts.

Feeding Value—For the average composition of barley, see *Appendix*. In some of the Pacific States, more particularly California, barley is used as a food for farm animals in the place of oats and corn, since it grows better there than either of these crops. Judged from the standpoint of analysis and digestibility, barley has about the same feeding value as wheat or corn, and a little greater feeding value than bran or oats. Bald barley is richer in protein than common barley. In experiments at the Colorado Station with growing pigs, ground bald barley gave a half better gains and common barley a twelfth better gains than whole barley. Ground common barley proved equal in feeding value to ground corn. With ground bald barley a half less food was required to make a pound of gain than with ground corn. Either of the barleys fed whole gave better results than corn fed whole. "Ground common barley required one-third more food for each pound of growth than ground bald barley." When ground barley and ground corn were fed together better results were obtained than when each was fed alone. In some fattening experiments with pigs in Wisconsin, Henry found ground corn meal about 8 per cent better for the purpose than ground barley meal. Barley meal and middlings gave slightly better gains in feeding experiments with pigs at the Ontario Agricultural College in 1900 than corn meal and middlings.

Some tests with steers at the Colorado Station place ground corn ahead of ground barley for feeding. The flesh of the cornfed steers was firmer and shrank less in shipping. Ground wheat and beets also gave better results with steers than ground barley and beets. With lambs at the same station corn, either ground or whole, gave more growth than common barley. Bald barley gave slightly more growth than corn when given in moderate feeds, "but when the amount was raised above a pound per day per head the lambs were unable to digest it and went off feed. Corn and bald barley mixed gave no better results than corn alone." Barley may be fed with roots to cows with good results. When fed to horses, as is done in California and some other portions of the West, the grain should not be ground but fed whole. The ground grain makes a pasty disagreeable mass in the horse's mouth. Barley is considered especially valuable in the production of bacon hogs.

In feeding experiments with horses at the North Dakota Station "barley was not equal to oats in feeding value per pound, but was nearly as good. Mules did not relish barley. Malted barley was not so valuable for work horses as oats and was not equal in value to the dry barley from which it came."

The prejudice which exists in this country against the use of barley as a stock food is unfounded. It is not quite so good for fattening purposes as corn; but for growing animals—especially pigs —it stands at the head of the grains, and produces flesh of the finest quality. In curing barley or in later operations, the grains often become discolored and consequently bring a low price in the market. Such grains are just as valuable for feeding, though diminished in value for malting. The value of malted barley or brewers grains for stock is discussed under *Feeding Farm Animals*.

Barley hay does not possess a high feeding value and is only grown where more valuable grasses and hay plants do not succeed. For a further discussion of the feeding value of barley see under all the different farm animals and poultry.

Enemies—Barley is attacked by 2 smuts, covered smut (*Ustilago hordei*), and naked smut (*U. nuda*). Barley kernels attacked by the first species become filled with a black mass which remains intact even after harvest. The other species has a similar effect but the black mass breaks up and falls away as soon as mature. For treatment see under *Oats*.

For ERGOT see under *Rye*.

For RUST see under *Wheat*.

The leaves are subject to blights caused by 2 or more species of parasitic fungi. In 1 form of the disease the leaves are marked transversely, in the other longitudinally. These diseases are seldom very serious.

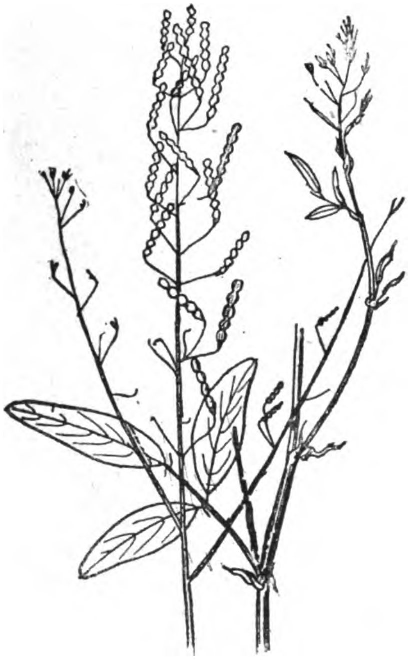


Fig. 7—BEGGAR WEED

For JOINT WORM see under *Wheat*.

For HESSIAN FLY, which sometimes attacks barley, see under *Wheat*.

For GRAIN APHIS see *Plant Lice*, under *Cabbage*.

BEGGAR WEED (*Desmodium tortuosum*)

An erect annual leguminous plant growing from 3 to 8 feet high and adapted for culture as a forage plant and soil renovator in the more Southern States. As compared with alfalfa, velvet beans, soy beans, and cowpeas, the United States Department of Agriculture says of it: "It is perhaps the best of these for the lighter sterile sandy soils, including the hammock and pine lands of Florida and the sandy pine lands along the Gulf coast." From 5 to 6 pounds of clean seed is sown per acre. If grown for hay, from 8 to 10 pounds should be used. The seed is sown when the ground is warm and moist. The seed need not be covered if sown at the beginning of the summer rains. If seeded early 2 crops may be secured the first season. It should be cut for hay at the time the first flowers appear. The yield is from 3 to 5 tons of cured hay per acre, which is but slightly inferior to red clover in feeding value. It is an excellent crop to turn under for green manure, and is considered superior for this purpose to velvet beans when sown in orchards. It may be sown in the corn field at the last cultivation and will furnish good pasture for the rest of the season. It does not become a weed. At the Florida and Louisiana Stations it has given good results. Cows and sheep are said to be very fond of it. Blossom and seed spikes are seen in Fig. 7.

BERSEEM (*Trifolium Alexandrinum*)

Also called Alexandrian and Egyptian clover. This is the clover of Egypt. It is the principal crop used there for green forage and hay as well as the chief manure crop. It is an annual clover. The plant is somewhat similar in appearance to Crimson clover except that the blossoms are white, the heads shorter, and the leaves narrower. There are 3 principal varieties—Muscowi, which is the most important variety and requires an abundance of irrigation water; Fachl, a luxuriant heavy yielding variety, much grown on land irrigated by the basin system; and Saida, a trailing variety that will grow on drier soil than either of the former. Berseem has been grown in the United States in only a few localities and then only on small experimental plats. At the South Dakota Station it made only a very light growth and was killed by frost before seed ripened. At several points in Delaware the crop proved a failure owing to the ravages of flea beetles. At the Kentucky Station it grew about 12 inches high and is suggested as a crop for testing on overflowed bottom lands. The plants winter-killed in the grass gardens at Washington, D. C.

It is probable that in this country berseem will be found suited for culture in only some of the milder Southern and Western States, and more particularly in regions where irrigation is practiced. At present it has only an experimental value. A complete account of this crop may be found in Bulletin No. 23 of the Bureau of Plant Industry, United States Department of Agriculture.

BROOM CORN (*Andropogon sorghum vulgare*)

Is a non-saccharine variety of sorghum. It is grown for the fine stems composing the head or panicle which are used in the manufacture of brooms and like articles. (See Fig. 8.) Broom corn culture is most extensively practiced in the middle West. The crop can be successfully grown, however, wherever corn or sorghum will thrive. It resists drouth better than corn. The best soil for broom corn is a well drained rich loam. The ground should be prepared as for corn. Poor soils should be well fertilized with barnyard manure. Just before the seed is sown the soil should again be well harrowed to destroy all weeds.

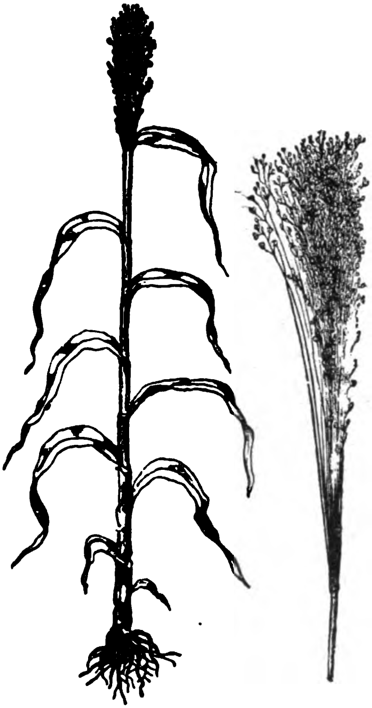


Fig. 8—DWARF BROOM CORN

Planting and Cultivation—The seed should be sown about the time or soon after corn is planted. Seeding in drills is generally recommended, though hill culture is sometimes practiced. The rows are made 3 to 3½ feet apart and the seed drilled to stand 6 to 8 inches distant in the row. On rich land more seed should be sown and the plants made to stand 3 to 4 inches in the row. When planted in hills 6 to 8 seed are put in each hill and these spaced 16 to 18 inches apart in the row. About 2 quarts of seed is required per acre. Broom corn starts into growth slowly. Prompt and frequent shallow cultivation is therefore necessary to keep the weeds from outgrowing and smothering it. Broom corn does best when rotated with other crops. Crops of clover, cowpeas, or other leguminous plants prepare the land well for broom corn.

Harvesting and Curing—Broom corn is usually harvested for brush when the seed is in the dough stage. Experienced growers, however, are not unanimous on this point. At harvest time the stalks of each 2 rows of standard varieties are bent down diagonally toward each other in such a manner that the bent parts support each other in a nearly horizontal position. The bend in the stalks is made about 3 feet from the ground. The crossed stalks form a kind of platform or table on which the heads, with about 6 inches of the stalks attached, are laid after being cut. The heads should be left on the tables about a day to dry out. The color of the brush is injured by rain or heavy dew. When possible it should be cured entirely under a shed; but if the green brush is brought in directly from the field it must be cured in thin layers, which requires considerable shed room. If the brush is cured a day in the sun it can be put in much deeper layers in the shed. The heads of dwarf varieties of broom corn are pulled by hand directly instead of being bent over and cut off as with standard varieties.

The seed is removed by holding the brush between revolving cylinders like those used in threshing machines. A machine capable of threshing 30 to 40 acres of brush in a day can be bought for $150 to $200. For small quantities of brush a long-toothed curry comb or like implement may be used. After the seed has been removed, the brush should be put in piles and left to cure in the shade until the stems break quite readily, when it is ready for baling. Large growers have especially constructed curing houses with racks on which the brush is cured. The cured brush is pressed into bales 45 inches long by 26 inches deep, weighing about 340 pounds. The butts are placed evenly at the ends of the bale and the pieces of brush lop in the middle, as seen in Fig. 9.

A good average yield ranges between 400 and 700 pounds of threshed brush per acre. The price per ton varies widely, but will average between $70 and $80. Broom corn is as easily grown as corn and the market can be easily oversupplied. There is considerable risk in planting large areas to broom corn in localities where it has never been grown unless the grower is reasonably certain of a remunerative market.

Feeding Value—Broom corn fodder is woody and of inferior value. Little use is generally made of it beyond letting the cattle run in the field after harvest. The chemical composition of the ripe seed, however, indicates that it is but slightly inferior to the corn kernel. It is fed to hogs and poultry and sometimes ground into meal for griddlecakes. No feeding experiments with this material have been reported by the experiment stations.

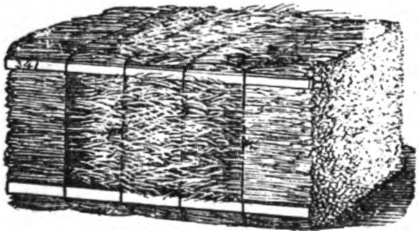


Fig. 9—BALE OF BROOM CORN

Varieties—There are a number of varieties of broom corn. The Evergreen is generally considered the most satisfactory of the large growing sorts. The Oklahoma Station states that Mammoth Dwarf, Improved Evergreen and California Golden have proved most satisfactory in that section.

Diseases—A smut, *Cintractia sorghi-vulgaris,* sometimes attacks the heads of broom corn, resulting in inferior brush. Experiments at the Illinois Station show that the disease can be controlled by soaking the seed for 15 minutes in water heated to 135° F. For further cultural notes, see U. S. Dept. Agr. Farmers' Bul. 174, Okla. Expt. Sta. Press Bul. 70.

BUCKWHEAT (*Fagopyrum esculentum*)

Buckwheat is one of the minor grains of the United States. It is used primarily for human food, more especially when prepared in the form of griddlecakes, also for feeding to chickens and sometimes to stock. The plant is used to a limited extent for green manuring. For this purpose it adds humus to the soil but no plant food. It is frequently grown as a honey plant. Its prolonged blossoming period and the large nectar content of the flowers make it especially valuable for this purpose, though the honey produced from it is dark and inferior in quality. Buckwheat frequently shades the ground to such an extent as to cut off the light and thus destroy weeds. It is valuable for this purpose.

Two-thirds of the total buckwheat crop grown in the United States is produced in the States of New York and Pennsylvania. Small amounts, however, are grown in nearly all the other States. In 1902 the average yield in New York was at the rate of 17.7 bushels per acre and in Pennsylvania 18.1 bushels per acre. The price averaged 60 cents per bushel. On good ground yields of 40 bushels per acre, of 48 pounds per bushel, are not uncommon. But little experimental work has been done with buckwheat in this country.

Soils—Buckwheat will grow on land where most other crops will starve; but for good yields a fertile well-drained sandy loam is desirable. It will not do as well on heavy clays or on wet lands. Usually only the poorer lands of the farm are sown to buckwheat, the better lands being reserved for the more exacting crops. It is a valuable plant to turn under as a green manure on poor sandy lands where clover fails to catch; for while it adds no fertility, it makes humus in the soil, thus increasing its water holding capacity for the better growth of some succeeding crop.

Seeding—Buckwheat is a tender plant and easily killed by frost. It grows from 2 to 2½ feet high and requires only about 70 days to fully mature from the time the seed is sown. On account of this rapid development it is frequently used as a catch crop. In the South buckwheat may be planted any time from May to September; but in the Northern States it is usually sown between June 15 and July 10. The seed is sown from 2 to 3 inches deep, either drilled or broadcasted. The latter is the more common method. From 2 to 3 pecks are sown per acre. The better the land, the greater should be the amount sown. The seedbed should be prepared in the same manner as for any of the other grains. When planted for green manure, 2 crops may be grown in a season. The plant should be plowed under when grown for this purpose about the time it begins to blossom. It makes a fair soiling crop.

Fertilizing—In fertilizing the buckwheat crop, heavy applications of barnyard manure or other nitrogenous fertilizers should be avoided. Potash and lime are the elements most in demand by the plant and these can be best supplied in the form of unleached wood ashes. They should be applied at the time the seedbed is prepared at rates of 20 to 50 bushels per acre, depending on the poorness of the land. Moderate amounts of well-rotted barnyard manure may be profitably applied on soils deficient in humus. Buckwheat does well after grass. Comparing the demand on the soil made by buckwheat with oats, Russian studies have shown that in order to obtain even a low yield of oats the soil must contain much more nitrogen and somewhat larger quantities of plant foods than are required for a crop of buckwheat.

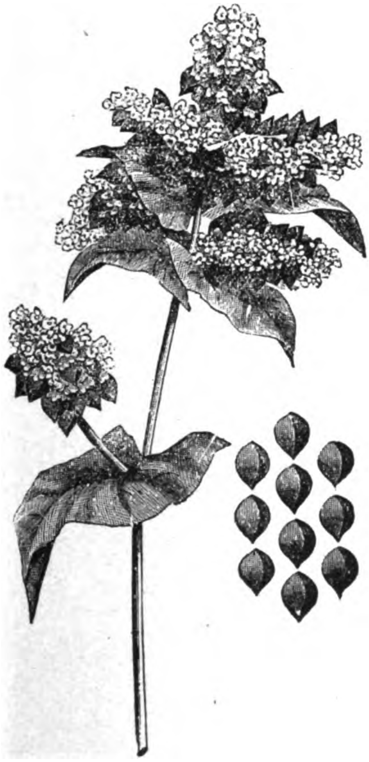


Fig. 10—JAPANESE BUCKWHEAT

Harvesting—The blossoming period of the plant extends over 3 weeks or more, so that the grain ripens unevenly. The best crop of grain will be secured if the crop is cut soon after the first seeds are ripe. If delayed longer than this, many grains shell out and are lost. The plant is quite succulent, and has to be cured, therefore, by setting up in small unbound or loosely bound sheaves in the field. The crop is threshed direct from the field without stacking. It must be handled carefully and as soon as dry. If allowed to stand in mass it quickly gathers moisture and is damaged. For this reason it is not usually stacked or placed in mows unless in layers with straw or like material between.

Varieties—The list of varieties of buckwheat is not long. Seedsmen usually advertise but 3 varieties: The Common, or dark-colored grain; the Silver-hull, which has light-colored grain; and the Japanese. (Fig. 10.) At the Massachusetts Station all these varieties developed in about 74 days. Silver-hull gave the best yield, followed by Japanese, and then the Common. Within recent years the Japanese variety has come more and more into prominence and is especially commended for the Western plains.

The Iowa Station states that it has had the most experience with the Silver-hull and common black buckwheat, but has grown the new Japan buckwheat near the old varieties for 2 years, and has found it much superior to either of them in several important respects. "It is larger and stronger, and stands up better during storms than the old kinds, and its seeds are also larger. But the characteristic which places it far ahead of other varieties, is that of setting full crops of buckwheat in dry hot weather. It can be sown much earlier than the Silver-hull or black varieties, so as to avoid losses by early frosts." All varieties are about equally valuable for flour.

Feeding—For the composition of buckwheat see *Appendix.* The whole grain of buckwheat is considered a valuable poultry food, more especially for chickens. It is much more generally used in France for this purpose than in America. The general claim is made that feeding buckwheat promotes egg production early in the winter season, and gives a good flavor to the meat. The outer black hulls of the grain have only very slight food value, but the kernels inside this covering which form the buckwheat middlings are rich in protein and have a high feeding value.

A good grade of buckwheat middlings proved superior to a mixture of corn and bran, or of cotton seed and linseed meal, for dairy cows at the Vermont Station. The middlings were fed with hay and silage. They made cheaper milk and considerably cheaper butter than the cotton-seed-linseed ration, and gave 3 per cent more milk and 6 per cent more butter at 2 per cent less cost than the corn and bran ration. Buckwheat middlings should be fed only in limited quantities, as cattle do not take to them kindly and they may slightly injure the quality of the butter.

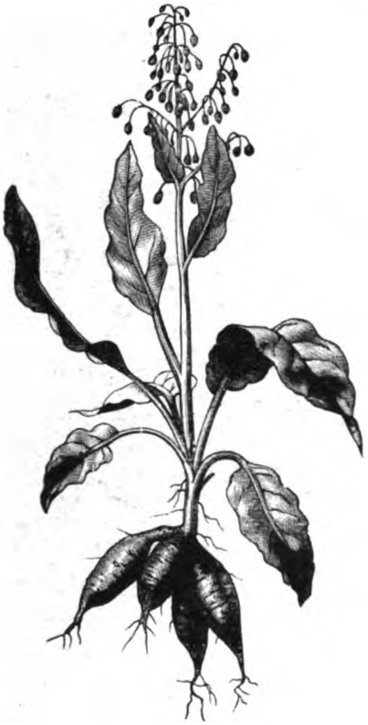


Fig. 11—CANAIGRE PLANT AND ROOTS

Buckwheat bran consists of a mixture of both hulls and middlings. It is fed to milch cows and believed to be conducive to a large flow of milk. The charge that buckwheat by-products make a white tallowy butter and pork of low quality is probably without foundation, providing the feed is not given in excess. As a single grain ration it tends to the production of soft pork and lard. (See under *Pigs.*) Canadian experiments show that ground buckwheat is not quite so good for pigs as ground wheat, though the difference in favor of the wheat was but 6 per cent. When the straw is well cured it makes a good fodder for sheep and cattle. If spread on the land it rapidly decays and makes a good fertilizer.

Enemies: MILDEW (*Ramularia rufomaculans*) is reported from Connecticut as attacking the lower leaves and gradually working upward. Infested stubble should be burned and a rotation of crops followed.

Buckwheat is remarkably free from insect pests.

CANAIGRE (*Rumex hymenosepalus*)

This plant grows wild and seems particularly adapted for culture in the sunny winter climate of the Southwest from the Indian Territory to Southern Utah and south into Arizona, New Mexico, Texas and Southern California. It will grow in other parts of the country but the roots do not seem to develop so well. It is gathered and grown for the tannin which it contains.

The plant resembles sour dock in appearance, as seen in Fig. 11. It attains a hight of 1 to 3 feet; the leaves vary from 2 to 16 inches in length and from ovate to lanceolate. The seed is ⅛ to ¼ inch long and 3-cornered like buckwheat. The valuable part of the plant is its tuberous roots, which in general appearance much resemble sweet potatoes. These are borne in clusters of 2 to 15 in an upright position 3 to 12 inches below the surface of the ground. The tubers are 2 to 4 inches long and weigh from 2 to 20 ounces each. The tannin content of these roots has been found by many analyses to vary between 8 and 38 per cent and to average for the older roots above 20 per cent in the air dry condition.

A sandy loam soil is most suitable for the culture of canaigre. The ground requires about the same preparation as for potatoes. The plants may be propagated from seed; but the usual method is from the roots planted 3 to 4 inches deep. Young roots are preferred for this purpose by the Arizona Station. When these are planted at 1-foot intervals in rows 3 feet apart it requires about 900 pounds of 1-ounce roots to plant an acre, or about a ton of 2-ounce roots. Cultivation should be given sufficient to keep down weeds and maintain a loose soil mulch. Wild canaigre makes its growth during the winter and early spring, and by June 1 has seeded and the tops died down. The roots remain dormant during the summer and do not start into growth again until after the winter rains. In Arizona the best time for planting is between September and March; but in Texas the planting season occurs from May 15 to September 15. The roots are harvested after the full period of growth and when in a dormant condition. A yield of 10 tons of green roots per acre may be expected if the crop is dug at the end of the first season, or from 15 to 20 tons if dug the second or succeeding season. It cost $16.50 per acre to grow canaigre at the Arizona Station. The crop is prepared for market by slicing the roots into pieces 1-20 to ¼ of an inch thick and drying in the sun. In drying the crop loses about two-thirds of its weight. Sometimes the roots are kiln dried. The temperature for this purpose should not exceed 120° to 130° F. Fermentation of the roots or a temperature above 150° F. will destroy the tannin.

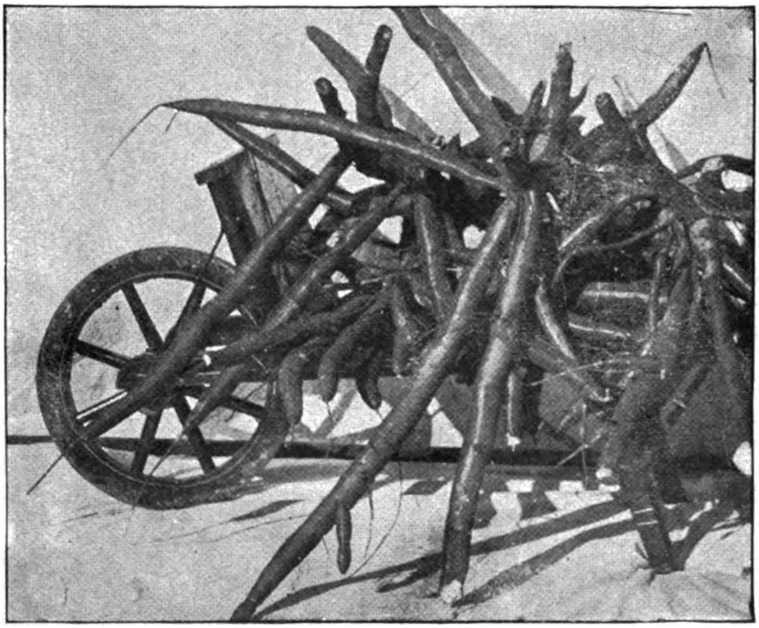


Fig. 12—CASSAVA ROOTS
(Fla. Expt. Sta. Bul. 35)

The cultivation of canaigre cannot be undertaken profitably on a small scale because of the expense involved in the preparation and marketing of the product; but on a co-operative plan with a central plant for slicing and drying the roots or extracting the tannin the industry will probably give good returns in regions adapted to its best growth. The plant has no serious insect enemies or diseases. For an extended account of the culture and uses of this plant, consult Ariz. Expt. Sta. Buls. 7 and 21, Tex. Expt. Sta. Bul. 38, Cal. Expt. Sta. Bul. 105, Fla. Expt. Sta. Bul. 35, and U. S. Dept. Agr., Office of Expt. Stas., Circ. 25.

CASSAVA (*Manihot* spp.)

This is a starch-producing plant, native of tropical America but adapted for cultivation in Florida and some of the Gulf States. It is commercially grown in Florida for the production of starch. The roots, or more properly the enlarged underground stems, constitute the valuable portion of the plant. These are from 1 to 3 inches in diameter, and from 1 to 3 feet long (see Fig. 12), and analyze about 20 per cent starch and 3 per cent sugar. The portion above ground assumes the form of a luxuriant many-branched shrub from 4 to 6 feet high and as far across. (See Fig. 13.)

There are 2 varieties of cassava, the bitter and the sweet. The bitter (*Manihot utilissima*) contains hydrocyanic acid stored in its roots, and is poisonous. It is grown mostly in the tropics, is distinguished by having 7 divisions to its palmately formed leaves, and is the variety from which tapioca is obtained. The sweet variety (*Manihot Aipi*) shows but 5 or less points to its palmately divided leaves and is non-poisonous. This is the variety grown in Florida. Relative to its value in Florida, a recent bulletin states "that, all things considered, cassava comes nearer furnishing the Florida farmer with a universally profitable crop than any other which he can grow on equally large areas. It can be utilized in more ways, can be sold in more different forms, can be more cheaply converted into staple and finished products, and can be produced for a smaller part of its selling price than any other crop."

The vast areas of pine lands in that State are considered perfectly adapted to the culture of this crop, which thrives best on moderately fertile sandy soils. It is claimed that it will withstand drouth better than any other staple crop. Portions of the regions from North Carolina west to Oklahoma and Texas are considered adapted to its culture. It requires about 7 months' immunity from killing frosts to come to full maturity.

Culture—The land for cassava should be deeply and thoroughly prepared as for corn, the rows plowed out 4 feet apart each way, and the seed or canes dropped and covered at the intersection of the rows. The crop is not an exhaustive one. Fertilizer experiments at the Florida Station show that cassava does best on the poor sandy soils of the station when fertilized with a mixture of 150 pounds of cottonseed meal, 62½ pounds of acid phosphate, and 37½ pounds of muriate of potash per acre, applied together, a short time before planting.

The plant seldom produces seed in Florida, and therefore portions of the stems, as is the case with sugar cane, are used to propagate the plant. The entire portion above ground, with the exception of the leaves and tip stems, is used for this purpose, being cut into sections about 4 inches in length. These are preserved over winter by placing the butt ends of the canes at a slight angle in freshly plowed ground, and overlapping them like shingles. When the bed is large enough for convenience the canes are covered over with straw, hay, or moss, and this with a light layer of soil. Thus cared for, the canes will endure perfectly over winter and be ready for planting out in the spring. Two canes are dropped at each furrow intersection and are covered by a turn plow or like implement. The first cultivation after the plants are up may be

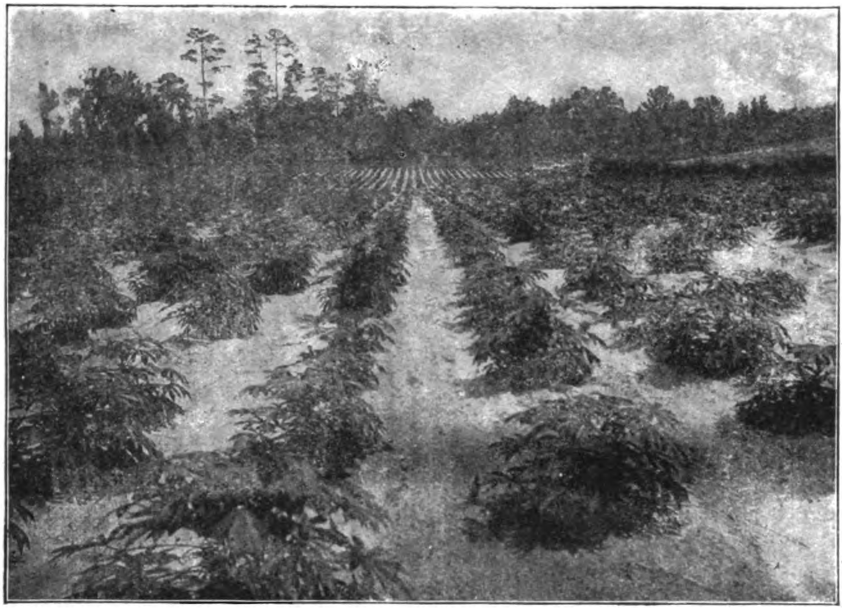


Fig. 13—FIELD OF CASSAVA IN FLORIDA
(U. S Dept. Agr.)

deep, but after-cultivation should be shallow and frequent as for corn. When the plants reach out and cover the ground pretty well cultivation may cease. At this stage, which will occur about the first of August, the Florida Station recommends that a single row of cowpeas be planted in the middle of the rows.

In light soils the roots are easily harvested. The tops are first cut off with a hoe 4 to 6 inches above the ground, and the roots then pulled out by hand, the more tenacious ones being loosened with a shovel. The Florida Station experiments show that, contrary to the usual belief, the roots can be easily preserved out of the ground for several months after harvesting if care is taken to keep them in a dry and reasonably cool place. It is more convenient and usual, however, to let them remain in the ground until wanted for use. The average yield of roots at the Florida Station was at the rate of 6½ tons per acre.

Use—The use of cassava in the production of starch has been spoken of. It is also valuable for the production of glucose and for human consumption and feeding to stock. In feeding experiments with pigs at the Florida Station cassava proved superior to corn, chufas, or peanuts for fattening purposes, a pound of pork being produced with cassava at a cost of about 1 cent, while the average cost with other feed stuffs under like conditions was more than 3 cents per pound. The cost of live weight beef produced by feeding cassava was about 1.1 cents per pound. These results are remarkable and need confirmation. As cassava is a carbonaceous food, rich in fat-producing material, it should always be fed along with more nitrogenous food, such as peas, vetch, clover, etc., to form a more nearly balanced ration.

As a raw material for the manufacture of starch, an acre of cassava yielding 6 tons of roots will give about 2400 pounds of starch, while an acre of corn yielding 40 bushels will give but 1200 pounds of starch, or only one-half as much as an acre of cassava. "It thus appears that cassava is to-day the cheapest known source of starch, costing at present market values of raw material only about one-fourth as much as its nearest competitor." For a further account of the culture and uses of cassava consult U. S. Dept. Agr. Farmers' Bul. 167 and Fla. Expt. Sta. Bul. 49.

CASTOR BEAN (*Ricinus communis*)

This plant is grown to a limited extent as a farm crop in a number of the Southern States and as far north as Kentucky. As an ornamental it is grown as far north as Canada. It is sensitive to frost. In the tropics it is more tree-like in appearance. growing sometimes 30 feet high, and perennial. It decreases in size northward and is cultivated as an annual, growing from 4 to 8 feet high. (Fig. 14.) As is well known the castor oil of commerce is obtained from this plant.

A fertile, well-drained, sandy loam is preferred for this crop; but any soil suitable for the production of wheat or corn will give good results with castor beans.

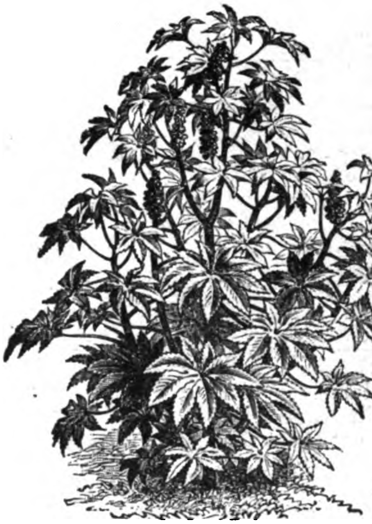


Fig. 14—CASTOR BEAN PLANT

Prepare the ground by plowing to an average depth and harrowing thoroughly. Rows laid off 4 to 5 feet each way, with wider spaces about every sixth row to admit a sled or wagon for gathering the beans, is the common method of planting. Six or 8 beans are planted at each intersection and thinned to 1 plant in a hill when danger from cutworms is past.

At the Oklahoma Station, the best results were obtained when the beans were planted every 15 to 18 inches in rows 48 inches apart. The best time for planting at the station was found to be about the middle of April. When planted this early the crop began ripening the third week in July. The best yield at the station was 12.9 bushels per acre.

To aid in the germination of the beans and to secure a more even stand, hot water a little below boiling point should be poured over them, and they should be allowed to soak in this for about 24 hours before planting. Without this preparation they germinate slowly, many not making their appearance above ground for 3 or 4 weeks.

Cultivate level to keep the soil mellow and to destroy weeds as for corn. After the plants are about 2 feet high they are capable of taking care of themselves and grow very rapidly.

The beans are produced in husks or pods on spikes of various lengths. If allowed to get overripe they pop out and the beans are scattered over the field and lost. To avoid this the entire spike should be cut off as soon as the pods begin to turn brown. Each plant bears a number of spikes which commence ripening in July and continue till frost comes, therefore the field must be gone over a number of times. The cut spikes are thrown in a wagon and hauled away to dry in the sun, either on a board floor or on ground packed hard by rolling. Board floors are best. Boards should be placed around the sides to prevent the beans from popping outside the space allotted them.

The spikes should be turned occasionally until all the pods have burst open and the beans left them, when they should be taken away and a new supply brought from the field. Care should be taken not to let the beans get wet, as this injures the quality and lowers the selling value. After each drying the beans should be swept up and run through a fanning mill to clean them; after which they should be stored in a dry place.

After the beans commence ripening the field should be gone over regularly twice a week until frost comes, and all ripening spikes gathered. Frosted beans bring about one-half price, but should never be mixed with good beans, as this lowers the price of the whole lot.

The pods have been analyzed by the Oklahoma Station and found to have about the same composition as good wood ashes. One thousand pounds of castor beans were found to contain 35 pounds of nitrogen, 4 pounds of potash, and 14 pounds of phosphoric acid. The pods gathered with this amount of beans weighed about 800 pounds and contained 13 pounds of nitrogen, 46 pounds of potash, and 1½ pounds of phosphoric acid. If the pods are returned to the soil it will be seen that the castor bean is not a hard crop on the land. A ton of the bean pods has a value as a fertilizer on the farm of about $10. There is no market for them. One hundred pounds of clean dry spikes will produce about 55 pounds of beans and 45 pounds of pods.

Castor beans are usually marketed in the large cities of the East. Prime beans are bright, uninjured beans, weighing not less than 41 pounds to the measured bushel when cleaned. No. 2 beans weigh not less than 38 pounds when cleaned and are valued at 5 per cent less than prime beans. They must be bright and uninjured. Rejected beans are those slightly damaged by rains which weigh not less than 38 pounds per measured bushel. No-grade beans are those badly damaged both by rain and frost or weigh less than 38 pounds per measured bushel when cleaned. The beans contain from 40 to 54 per cent of oil. For suggestions on the improvement of the castor oil plant see Okla. Expt. Sta. Bul. 54.

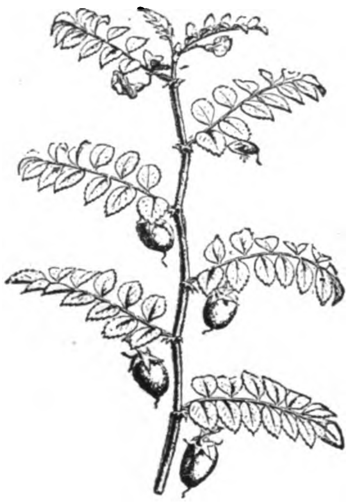


Fig. 15—CHICK-PEA

CHICKEN CORN (*Sorghum vulgare* var.)

This is a variety of sorghum which has become naturalized and grows wild over a considerable portion of Western Alabama and Eastern Mississippi. In many cultivated fields it is a serious weed pest and has to be cut down 4 or 5 times during the season. The plant in appearance is similar to ordinary broom corn, though the heads are less spreading and the stalks usually branch at several of the joints, so that each bears a number of heads. It is especially abundant in cornfields, starting into growth after the corn is laid by. It matures rapidly and by September the corn in many fields is entirely hidden, and it appears as though the field were planted with common sorghum.

If cut before heading the plant makes excellent hay. At the Alabama Canebrake Station it yielded at the rate of 22,520 pounds of green fodder per acre at the first cutting, which was used for silage, and gave 3760 pounds of cured hay at the second cutting, September 30. When the crop is allowed to mature the yield of seed is about the same as that of the ordinary cultivated varieties and is worth about as much for stock feed. In feeding experiments with hard working mules at the Mississippi Station chicken corn grain proved about equal in the ration to corn. That station further states that the seed can be gathered at an expense of 10 cents per bushel and that many planters make a practice of saving it to use in place of corn, though it is sometimes difficult to keep on account of the attacks of weevils. For composition see *Appendix*.

The crop is considered excellent for silage. In seeding for this purpose the Alabama Canebrake Station recommends that it be planted in rows 3 feet apart and from 12 to 18 inches in the drill. When sown broadcast the crop seems to be hard to handle. A crop seeded April 2 matured for silage July 20.

The Mississippi Station states that care must be taken that cattle do not break into the field when chicken corn is making a second growth late in the season. When eaten at that time the results are often fatal and sometimes so within a few minutes.

(Consult also Ala. Canebrake Expt. Sta. Bul. 9; Miss. Agr. Expt. Sta. Bul. 8, Bul. 20.)

CHICK PEA (*Cicer arietinum*) [also called gram or Idaho pea]

This pea has been long cultivated in eastern countries, especially India, for its seed, which is used for stock food and sometimes for adulterating coffee. The plant is an annual with vetch-like leaves, divided into 7 leaflets. It grows from 12 to 18 inches high, is sensitive to frost, and better adapted to culture in arid or semi-arid regions than to humid ones. The pods are from ½ to ¾ inch long and contain 1 or sometimes 2 wrinkled peas a little larger than the common garden pea. A branch of chick pea is seen in Fig. 15.

The chick pea, while adapted to nearly all soils, makes its best growth on loams or clays. At the Colorado Experiment Station chick peas were planted in rows 30 inches apart, and 6 to 12 inches distant in the row. An excellent growth was secured where plenty of water was given, and a fair growth where there was a scarcity of water. The cost of production was about 1 cent per pound. From 30 to 50 pounds of seed per acre are usually sown. The yields vary from 10 to 30 bushels per acre, with an average nearer 15 bushels per acre. In composition, the chick pea is very similar to the common field pea. The leaves possess deleterious qualities and the forage is said to be poisonous to horses on account of an excess of oxalic acid in the leaves. The small growth of the plant renders it of little value as a green manure crop in comparison with some of our other more vigorous growing leguminous crops. The chick pea is as yet not much grown in this country, though frequently raised in some of the Western States. Until more is known regarding its growth in this country it will be well for farmers to plant only small areas.

CHICORY (*Cichorium intybus*)

Chicory is grown in a few places in this country primarily for its root, which is roasted and used as an adulterant of coffee. In many places the plant has become a weed. The young leaves of chicory are sometimes used like spinach, and in Europe the tender young roots are used as a vegetable, like carrots. The root of the chicory plant is on the order of the beet or salsify root, as seen in Fig. 17. The plant grows 2 to 4 feet high and bears pretty blue flowers on straggling, almost leafless, branches. (See Fig. 16.) It is only within the last few years that the plant has become agriculturally important in this country. Previously the root was imported almost entirely from Europe.

Experience here has shown that chicory is adapted to any good loam soil which will produce good root crops, and that it will thrive wherever the sugar beet does well. The most satisfactory fertilizer is well rotted stable manure.

Soil Preparation—Land for chicory should be deeply fall plowed. If this cannot be done, the earlier it is plowed after suitable weather comes in the spring the better. The seedbed should be well harrowed and worked down to pulverize all lumps and make it compact, and again harrowed just before the seed is sown to kill all germinating weed seed.

Planting—The seed may be sown after the weather has settled and the ground is warm. In Michigan and Nebraska where most grown this occurs about the middle of May. The rows should be from 18 to 24 inches apart if horse cultivation is intended and from 12 to 14 inches apart if the crop is cultivated by hand. From 1 to 1½ pounds of seed will be required per acre. It is best put in with a garden drill and should not be covered at most more than ¾ inch deep, and in heavy or wet soils not more than ½ inch deep. Should a heavy, packing rain come before the seed is up it will often be necessary to break up the crust by running over it a very light spike-tooth harrow made by driving wire nails through a wooden frame so as to project about 1½ inches.

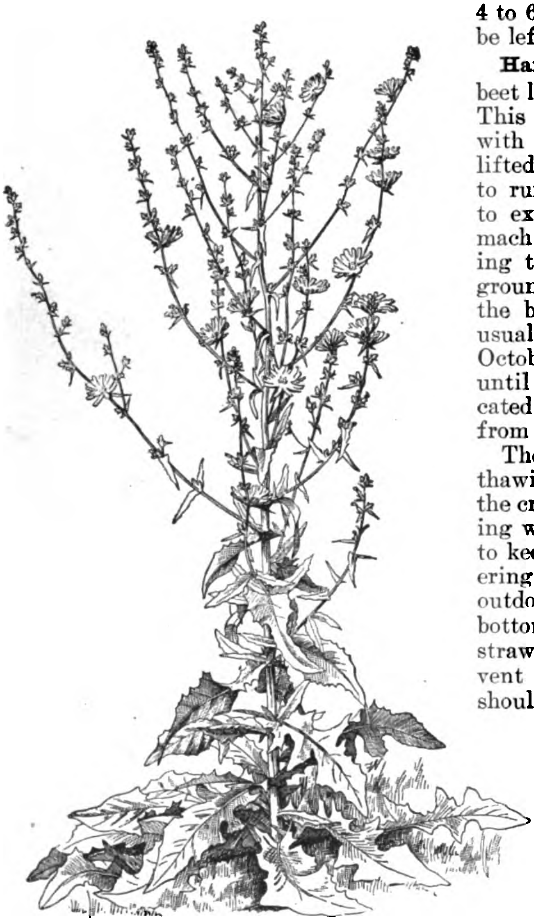


Fig. 16—CHICORY PLANT

Cultivation—After the plants are up they will need frequent shallow cultivation with some of the light cultivators made especially for sugar beets and chicory to kill the weeds and preserve the soil moisture. When the plants have attained a hight of about 2 or 3 inches they should be thinned out to stand from 4 to 6 inches apart. Only 1 plant should be left in a place.

Harvesting—In harvesting the crop a beet loosener may be run along the rows. This breaks the connection of the roots with the soil so that they can easily be lifted by hand. A less convenient way is to run a plow alongside the rows so as to expose the roots on 1 side. Special machinery has also been devised for pulling the roots. After removal from the ground the tops are cut off at the base of the bottom set of leaves. The crop is usually ready to harvest by the first of October. Chicory should not be pulled until the roots are ripe, and this is indicated by the disappearance of the milk from the roots.

The roots cannot endure freezing and thawing without rapid decay; therefore the crop should be harvested before freezing weather sets in. When it is desired to keep the roots some time before delivering to the factory they may be stored outdoors in piles 4 to 5 feet wide at the bottom and covered at first lightly with straw and earth, and later deeper to prevent freezing. The ridges of the piles should be left open for a few days to let the warm air escape.

Cost of Growing—The cost of growing a crop of chicory will average about $35 per acre. The yield on good land will vary from 6 to 8 tons per acre, oftentimes much more, and the price from $6 to $8 per ton. There is a good opening for a few farmers in the vicinity of factories for chicory growing. The demand, however, is easily supplied, and no farmer should undertake to grow chicory unless he arranges for his market before the crop is planted.

Varieties—There are several varieties of chicory, but the sorts generally grown for coffee adulteration are Magdeburg, Brunswick, and Elite. The crop is practically free from insect enemies. According to the Nebraska Station: "The leaves of the plant make a fair cattle food, but should not be cut or pastured off before harvesting. They should not be fed to milch cows, as they make the milk bitter." (See also U. S. Dept. Agr. Div. of Bot., Bul. 19; Neb. Expt. Sta. Bul. 49.)

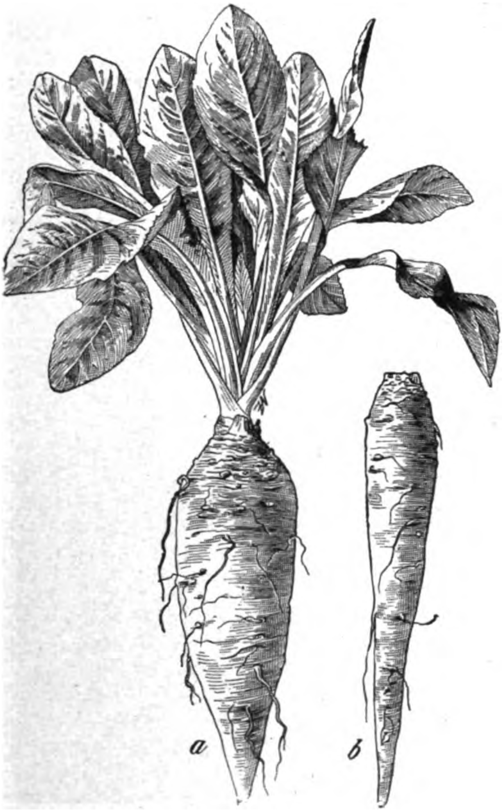


Fig. 17—CHICORY ROOTS AND LEAVES

a, Schlesische variety; *b*, Brunswick and Magdeburg varieties (one-sixth natural size)

CHUFA (*Cyperus esculentus*)

The underground tubers of this plant are known as nuts. They are eaten raw, baked, or made into coffee, and are much in favor in the South as a food for hogs. The tubers are oblong, ½ to ¾ inch long, cylindrical and hard. A crop of 1-3 acre at the Arkansas Station supported 3 hogs, averaging 122 pounds in weight each, for 46 days. The gain during this time averaged 66 pounds each, or a total of 198 pounds. The nuts proved much more effective for fattening purposes in this experiment than soy beans, and practically as good as dry corn. When grown for hog feed the hogs are allowed to gather the crop themselves by rooting. The yield per acre in this experiment was at the rate of 184 bushels.

On thin, sandy land at the Alabama Station the green yield was at the rate of 172 bushels per acre, and the yield when dry 115 bushels. At the Ontario Agricultural College the yield of nuts was at the rate of 23 bushels per acre. The plant is grass-like in appearance, as seen in Fig. 18, and in the North does not flower. Propagation is by means of the tubers. These are usually planted singly 2 inches deep and about 1 foot apart in rows 2½ feet apart. The crop is planted about the same time in the spring as corn and harvested in the fall. At the Arkansas Experiment Station the nuts were planted 12 inches apart in 3-foot rows. In the South the tubers may be left in the ground over winter. Those not gathered in the fall will grow the following spring. The Florida, Alabama, Arkansas and Louisiana Stations all highly recommend chufas as a crop for hogs. The nut is sometimes called "earth almond."

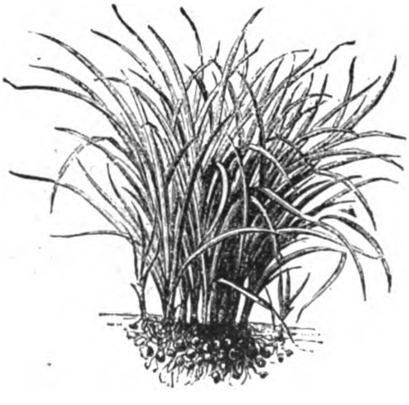


Fig. 18—CHUFA

CLOVER (*Trifolium* spp.)

There are several species of clover, the most important of which are the common red clover (*T. pratense*), mammoth red or sapling clover (*T. pratense perenne*), crimson or scarlet clover (*T. incarnatum*), white clover (*T. repens*), and alsike clover (*T. hybridum*). These different clovers will be treated separately in this article. Some closely related plants often called clovers are alfalfa, sweet clover and Lespedeza. In localities where the clovers grow well they furnish a large amount of nutritious forage much resembling in composition such concentrated feeds as the grains. (See *Appendix.*) They are also soil renovators. Their long roots penetrate deep into the soil, improving its drainage and friability, while through the nodules on them the plants utilize in their growth some of the free nitrogen of the air which is added to the soil as a fertilizer when the plants decay. (See *Leguminous Plants.*)

Common Red Clover (*Trifolium pratense*) [also called June clover]—This is the most important member of the clovers and constitutes the chief leguminous forage crop of the Central, Northern, and Eastern States. It will grow well in the South, but is generally replaced there by cowpeas and in the Western States by alfalfa. In addition to its use for hay it is widely grown for green manuring, for soiling and the silo. The plant is a biennial or perennial of a few years' growth, according to locality. It grows from 1 to 2 feet high and usually produces 2 crops in a season. The first crop is usually made into hay and the second crop cut for either hay or seed. Bumblebees are essential to the cross fertilization of the clover blossoms, and as these are not abundant early in the season, the second crop receives the benefit of their visit, and the heads are much more completely filled with seed. The yield of forage averages from 1½ to 3 tons of cured hay per acre.

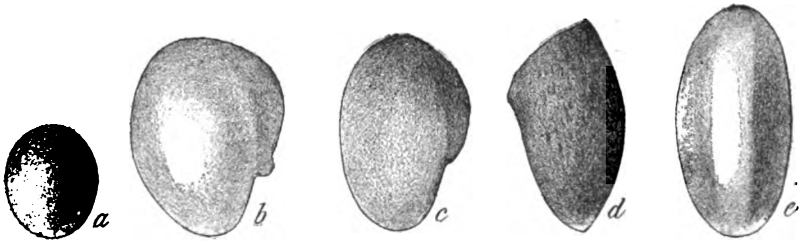


Fig. 19—RED CLOVER SEED AND SOME OF ITS IMPURITIES
a, dodder; *b*, yellow trefoil; *c*, common red clover; *d*, broad-leaved plantain; *e*, buckhorn (*Plantago lanceolata*) (U. S. Dept. Agr. Farmers' Bul. 123)

Soils—Red clover is adapted for growth on a wide range of soils, but it does best on good clay loam, well drained. On acid soils it does not thrive unless limed. It is a general saying among farmers that most crops are certain wherever red clover will grow. In renovating worn-out land clover is one of the first crops grown. It adds a large amount of vegetable matter and nitrogen to the soil and leaves in a more available condition considerable amounts of phosphoric acid, potash and lime. All crops grow well after clover.

Seed and Seeding—Red clover seeds are small, and at the Michigan Station entirely failed to grow when the depth of sowing was greater than 2 inches. Usually the depth of sowing should not exceed ½ inch. The seed is sown broadcast. If used alone, 10 to 12 pounds per acre is sufficient. It is customary to mix it with timothy or some other grass. In such cases 6 pounds per acre is sufficient.

Ordinarily, clover in the Northern States should be seeded in the spring. If fall seeded it is liable to winter-kill. It is a good practice to sow on the snow in March or April. As the snow melts the seeds are carried down into the mud and get an early start before drouth comes on in summer. The Iowa Station states that where wheat is seeded down with timothy and clover it is best to seed the timothy with the grain in the fall and sow the clover seed in the spring. If seeded late in spring the ground should be rolled after the seed is sown. As a nurse crop spring wheat is better than oats for clover.

In some localities difficulty is found in getting a good "catch" of clover when seeded with the grains. In such cases the ground should be thoroughly prepared and the clover seed sown alone without a nurse crop at a season in the year when drouth is not probable and lightly harrowed in. At the Michigan Station clover was seeded every month in the year, but only the February, March, April and December seedings were successful. The July seeding failed to come up until the fall rains began, and plants from seedings from July to October were winter-killed. Clover seed, especially the cheaper grades, is often badly adulterated with weed seeds. Fig. 19 shows the clover seed and a number of other seeds often found mixed with it.

Many experiments have shown that American seed is much better for planting in the United States than seed of European origin. Clover is seeded with a number of grasses, but chiefly with timothy to give variety to the hay produced. Timothy, however, matures about 2 weeks later than clover. Seeding 3 quarts of clover seed with 6 quarts of timothy seed is common. The first year after seeding, the clover will largely predominate in the mixture; the second, there will be about one-third clover and two-thirds timothy, and the third year timothy will occupy practically the whole ground. Orchard grass and tall oat grass mature in about the same time as clover, and are recommended by the Oregon Station in the proportion of 6 pounds clover, 6 pounds orchard grass and 6 pounds tall oat grass.

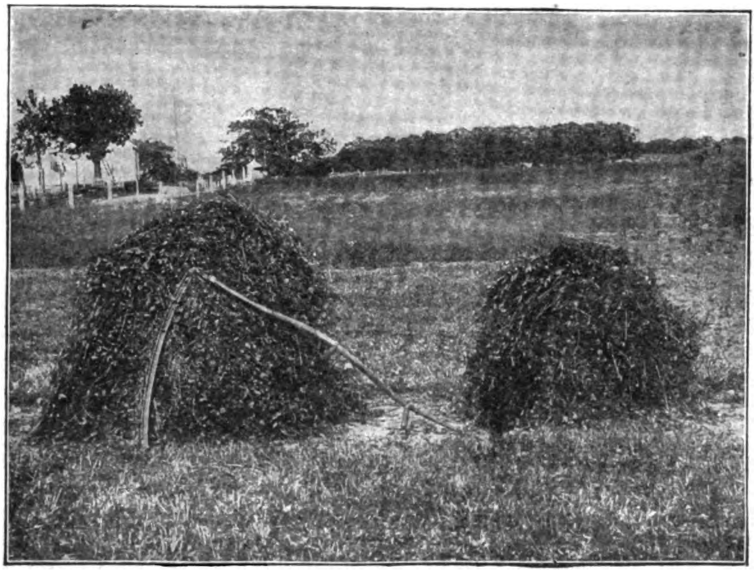


Fig. 20—EFFECT OF LIME ON CLOVER
Clover on left from limed plat, on the right from unlimed plat (R. I. Expt. Sta.)

Fertilizing—Clovers do not require the application of nitrogenous fertilizers, since they obtain a large part of this element from the atmosphere by means of bacterial life in the nodules on the roots. (See *Leguminous Plants.*) At the Rhode Island Station the growth of clover upon plats which had received no nitrogen for many years was practically as good as on plats which had been heavily fertilized with nitrogenous fertilizers for 5 years in succession. Lime or land plaster (gypsum) and wood ashes are the cheapest and among the best fertilizers for clover. (See Fig. 20.) The lime is not so valuable in itself, but it corrects soil acidity and makes available the potash in the soil, and this is the element most required by clover. The use of barnyard manure also practically insures a good crop. On most soils, however, the use of lime and wood ashes may be relied upon to produce a crop of clover. They both tend to "bring in" clover. Clover is "good for the land."

Cutting for Hay—Red clover should be cut for hay when in full bloom. At this time it contains the largest amount of nitrogenous material in the most valuable form for food. The largest amount of dry matter is found in clover at the end of the blooming period, but it is poorer in the valuable nitrogenous compounds at this time, besides being more woody.

In making hay great care should be taken to preserve the leaves, since these contain, according to the Minnesota Station analyses, two-thirds of the precious albuminoid matter of the plant (exclusive of the roots)—the constituent which gives clover its high feeding value. As soon as the leaves are thoroughly wilted the clover should be raked up and put into small piles to cure. In about 24 hours, with good, clear weather, the piles may be drawn into the barn or stacked. According to the Oregon Station the hay at this time may be a little tough and apparently too wet to go into the barn; but if there is no rain or dew on it, it will suffer no harm if packed close in the hay mow. The hay should be allowed to cure in the barn with the doors shut, on the same theory that it is desirable to keep air out of the silo. Some farmers mix salt with clover hay when they put it in the barn. The practice is of doubtful value. It is better to salt stock when they need it.

A program in the hay field is sometimes as follows: Commence cutting in the morning as soon as the dew is off. With hay averaging 1 to 2 tons per acre, no tedding is required. With a heavier crop the hay is either turned by hand or the tedder is run over it as soon as the top of the swath is well wilted. By 2 o'clock the hay cut in the morning will be ready to rake into windrows and put into piles. In good, hot, sunshiny weather all the morning hay cut, up till 10 o'clock, will be ready to go into the barn direct from the windrows that same afternoon. That cut later in the day is generally raked into windrows and put up into small piles ("cocks") to further cure over night. The latest swaths cut may be left till the following day, before raking. That piled up in the afternoon will be ready to go into the barn the following morning as soon as the dew is off and the outside has become thoroughly dry. It is always desirable to draw all the hay the same day it is cut, if possible, for if rain comes over night it makes a blackened hay of poor quality. Should rain come after the hay is cut, but before it commences to wilt, no harm is done whatever; and in "catchy weather" farmers frequently run the mower while it is raining so that it may be rapidly cured when sunshine comes.

Making Clover Silage—Clover is frequently put into the silo. In fact, as a silage crop it is second only to corn, and surpasses clover hay because of its succulence and palatability. Many leaves and the more tender parts of the plants which are the richest in food value and which in hay-making are lost, are also preserved. For the purpose of silage making, the clover should be cut at the same period of growth as for hay, but should be put into the silo while it is still green and before it has wilted. Even if the dew is on or if it is wet with rain it is satisfactory for silage. It should be run through a cutter; since when put into the silo whole it lays up loose, thus permitting the admission of air, which is the main cause of silage spoiling. (See *Silage.*) The cut clover should be well packed down in all the corners of the silo so that it is air-tight everywhere. Clover packs better if the silo is deeper than for corn. The fact that clover silage can be made in rain or sunshine and is fully or even more valuable than clover hay appeals to many farmers as one way of avoiding the anxiety of hay-making, and at the same time securing a quantity of excellent forage.

Cutting for Seed—As before noted, it is the second crop of clover which is used for seed. This is because the heads of the first crop are seldom well filled out. For seed purposes clover should be cut when the clover heads or blossoms are well browned or ripe. The clover may be cut with a mower, raked up, and put in piles to cure, as for hay. It should not be drawn into the barn or stacked until fairly well dried out. A better way is to cut the clover with a reaper or binder. By this method it is not dragged over the ground so much and less seed is lost by shelling out. An average yield is 1 to 2 bushels per acre, though 5 to 6 bushels are sometimes obtained.

Clover Hay for Stock—Clover hay contains more nitrogen than timothy or corn fodder, and practically as much as barley, oats, or corn. (See composition in *Appendix.*) It is therefore well suited as a roughage for all growing animals. Experience in feeding shows that it is pre-eminently suited as a fodder for sheep and cattle. It makes a more dusty hay than timothy, and is therefore not so well liked by stockmen as a forage for horses. Dusty clover is believed to conduce to the heaves (see under *Horses*) in horses. Clover should form, therefore, only a part of the roughage fed to horses. Sheep and cattle fed on clover hay require less grain in fattening than where fed on a roughage of grass, cornstalks or straw. Cut steamed clover hay is often fed as a green food for poultry in the winter.

Clover pasture is excellent for all animals. Hogs make good gains on it. Care should be taken when sheep and cattle are first turned on clover pasture to have them pretty well filled up and no rain or dew on the clover to prevent bloat. Bloat seldom occurs after stock get accustomed to clover pasture. In this respect clover is much less dangerous than alfalfa. As a soiling crop clover yields from 15 to 25 tons of green fodder per acre during the season, which may be fed to all animals.

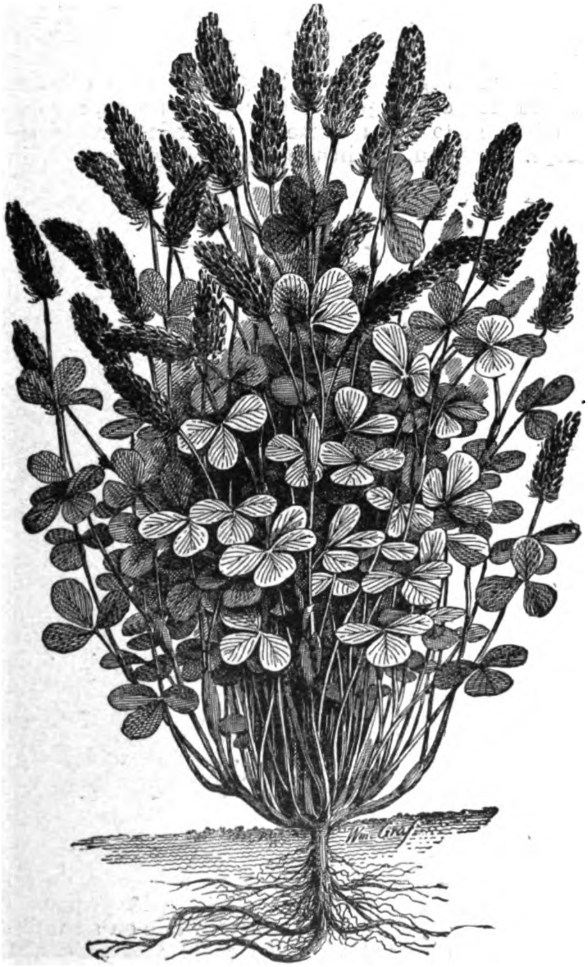


Fig. 21—CRIMSON CLOVER

Clover for Green Manuring—Clover is widely used as a green manure, the root and stubble being plowed under after the tops have been cut for hay. Sometimes the whole plant is plowed under, but this is not wise farm economy. It is better to cut and feed the hay, returning the manure to the soil, and turn under only the roots and stubble. According to the Minnesota Station, an acre of clover yielding 2 tons of hay has 1760 pounds of roots. These contain about 39 pounds of nitrogen, 27 pounds of potash, 28 pounds of phosphoric acid, and 24 pounds of lime. This amount of nitrogen, if purchased in commercial fertilizers, would cost about $6.63. In addition to the fertilizers in the roots, that contained in the stubble, crown and fallen leaves must also be added. The important facts regarding clover roots are that they add from 1500 to 2000 pounds of organic matter to every acre of soil, and from 30 to 50 pounds of nitrogen. They also change 20 to 30 pounds each of phosphates, potash and lime into more valuable forms of plant food for the use of succeeding crops. Where clover will succeed there is no crop grown that is better for green manuring.

Rotation—In the farm rotation, clover usually follows some one of the small grains, being seeded at the same time as the grains (except as noted above under seeding), and given the whole space after the grains are removed. It is cut for hay the following season, and possibly for 2 seasons. Corn or potatoes usually follow clover, but practically every farm crop, like sugar beets, tomatoes, melons, cabbage, etc., does well after clover. In any rotation on a general farm in the Northern States clover should reappear every third or fourth year.

(See also Minn. Expt. Sta. Bul. 34; Ore. Expt. Sta. Bul. 35; Mich. Expt. Sta. Bul. 125; U. S. Dept. Agr. Farmers' Bul. 123.)

Mammoth Red Clover (*Trifolium medium*)—This forage plant closely resembles common red clover, but is larger and coarser in appearance and ripens from 3 to 5 weeks later. The later maturing habit of the plant makes it better suited for mixing with timothy than common red clover, since they mature more nearly together. But 1 crop is secured in a season and seed is produced plentifully. The yield of forage is usually somewhat greater than from common red clover. It is planted and cultivated in the same manner as red clover and used for the same purpose. The seed cannot be distinguished ordinarily from that of common red clover. (For composition see *Appendix.*)

Crimson Clover (*Trifolium incarnatum*), also called scarlet clover, Italian clover, German clover, etc. This clover is an erect tufted annual, 1 to 2 feet high, with soft, hairy leaves and stems and usually bright scarlet flowers in elongated heads. A single plant is shown in Fig. 21, a full grown field crop in Fig. 22. It is a forage crop. Where it will succeed it makes one of the best orchard winter cover crops. It is unsurpassed as a soil renovator and for soiling purposes or for hay it fully equals red clover. The crop is not adapted for use in permanent meadows and pastures, and is too tender for successful general culture outside the region from New Jersey west to the Alleghany mountains and south to Eastern Tennessee and Texas. It is at its best in the Middle and South Atlantic States. It has been tested by the experiment stations in Rhode Island, New Yorl Ohio, Michigan, Illinois, South Dakota, and other States of the North and West, and while occasionally successful, particularly as a summer crop, it generally winter-kills badly when fall sown, and cannot be depended upon. Even in localities where crimson clover succeeds it is a supplement and not a substitute for the perennial forage crops like common red clover.

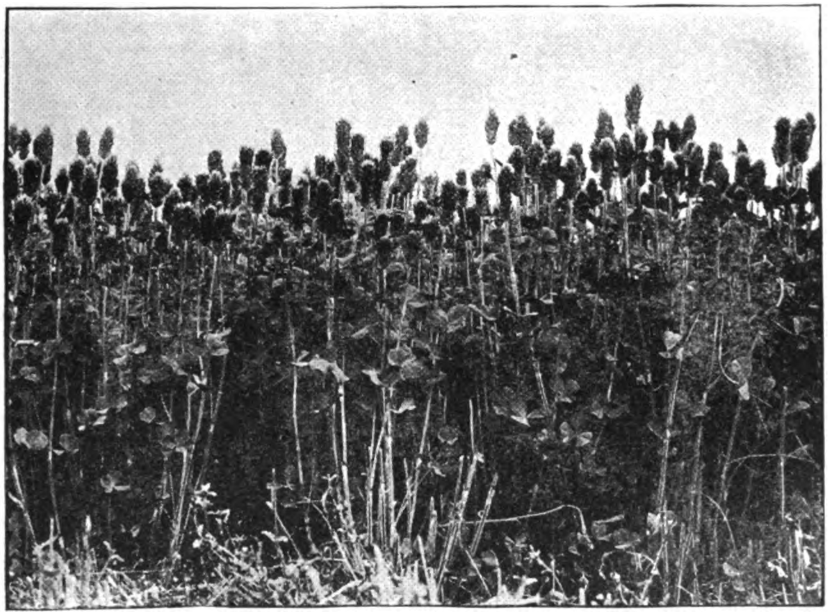


Fig. 22—A CRIMSON CLOVER FIELD

Soils and Fertilizers—Crimson clover will grow on poorer, thinner soils than red clover and is more efficient in renovating such soils than red clover. The best crops, of course, are secured on well drained, fertile loams. Experiments at the Alabama Station indicate that possibly many of the failures with crimson clover, particularly in the South, are due to the absence of tubercle-forming organisms in the soil. When that station inoculated crimson clover seed with these organisms the yield averaged 4057 pounds of cured hay per acre, while on an uninoculated plat the yield was only 761 pounds. On very poor, worn soils a moderate amount of phosphatic and potash fertilizers may be used, but no nitrogen. Lime has the same beneficial effect as on common red clover. Wood ashes are especially valuable.

Seed and Seeding—Crimson clover seed is larger than that of red or mammoth clover and is almost perfectly oval in shape. The seed has a bright, reddish-yellow color and a high polish. This color changes to a reddish-brown as the seed becomes older. Eventually the seed loses its polish and takes on a dull, dark reddish-brown color. Such seed should never be purchased, as it is too old to grow. American seed has proved more satisfactory here than European.

Crimson clover should be seeded at the rate of 12 to 15 pounds per acre. It may be sown either broadcast or with a drill. The former is the more usual practice, due largely to the fact that the clover is so often sown on land already occupied by some such crop, as corn, potatoes, or cotton. Here it is sown immediately after the last cultivation and without covering. It is not adapted for seeding with wheat or rye. When crimson clover occupies the ground alone it should be lightly harrowed or rolled in. If crimson clover is sown in the spring it makes a small growth, comes rapidly to maturity, ripens its seed the same season, then dies. If sown in summer or early fall it develops more slowly, lies semi-dormant through the winter, and completes its growth the following spring. It is the common practice in the Middle Atlantic and Southern States to sow the seed any time between July 15 and September 15. When seeded between these dates it matures the following spring from 3 to 4 weeks earlier than red clover.

Harvesting—This crop may be harvested in the same manner as common red clover. "It is sometimes difficult to cure properly, as it is ready to cut at a time when wet weather is likely to interfere. It may be cut for hay as soon as it comes into bloom and should never be cut for this purpose later than when it is in full bloom. The hairs upon the calyx of the flowers become hard and stiff as the plant matures and are likely to prove troublesome to animals eating the hay, forming 'hair balls' in the stomachs of the animals, which sometimes cause death. When harvested for the seed, cutting should take place as soon as ripeness has been reached, to avoid loss through shattering. It is also well to thresh the crop or put it under cover as soon as it is dry, as heavy rains may injure the seed by causing it to sprout in the head.

"Under average conditions from 8 to 15 tons of green, or 1½ to 3 tons of cured forage may be obtained from an acre of crimson clover. Very poor soil or drouth may result in a lighter yield, while as high as 20 tons are reported under favorable conditions. The yield of seed per acre usually ranges from 8 to 12 or 15 bushels."

Uses—As a hay plant, properly cut and cured, crimson clover is superior even to red clover. It is similar in composition (see *Appendix*) but richer in protein, its nutritive ratio being between 1:3.5 and 1:4. It is especially adapted for working and growing animals.

As a soiling crop crimson clover ranks high. It comes early in the season at a time when other forage plants are scarce and lasts about 20 days. At the New Jersey Station 1 acre of crimson clover yielded 2934 pounds of digestible food—a sufficient amount to maintain 10 cows in full flow of milk for 20 days. The green forage was found to contain 17 per cent more protein than red clover and 59 per cent more than green rye.

Crimson clover makes one of the earliest and best pasture crops. When 6 inches high at the New Jersey Station it contained over 1300 pounds of digestible food per acre, an amount sufficient to properly nourish 12 cows 1 week.

As a silage crop crimson clover is the equal of red clover and is cut and put up in the same manner. The silage is considered especially valuable for feeding to dairy stock.

It is, however, as a green manure crop that crimson clover has one of its most important uses. "Its season of growth is such that it can be used without in any way interfering with the production of the primary crop of grain or vegetables, and it affords a large amount of fertilizing material. The herbage is heavy, the roots are abundantly produced and penetrate deeply into the soil, and together these form a large amount of vegetable mold, exerting a beneficial effect on the physical condition of the soil as well as adding much nitrogen and other valuable elements of plant food to the surface soil where it will be available to corn, wheat, and other crops."

At the New Jersey Station a crop 6 inches high contained in the whole plant 104 pounds of nitrogen per acre; when 13 inches high it contained 168 pounds; in bloom 190 pounds; and when fully matured 212 pounds, having a value in the latter case of over $30, and equivalent to the nitrogen contained in 20 tons of city manure. When a heavy crop of crimson clover is turned under it decays more rapidly and is less likely to "burn" the soil than a heavy crop of cowpeas turned under. The crop is often seeded advantageously with cowpeas, the cowpeas being used as a summer crop and followed by the clover for the winter.

"Crimson clover is peculiarly well adapted to use as a cover crop. It may be sown in corn, tobacco, potatoes, cowpeas, sorghum, and many other crops after the last cultivation, and, when these are removed, will come on and occupy the land during the fall, winter, and early spring, and may be pastured off or plowed under in time for the planting of the next crop. It is an excellent cover crop for use in orchards, where it is also one of the best of sources of nitrogen for the trees. Crimson clover in the orchard reduces the amount of cultivation necessary to keep the weeds in check, and if the crop is not needed for fertilizing the soil, it can be cut for hay, soiling, or silage. The roots and stubble left on the ground from a crop of clover cut when in full bloom at the New Jersey Station contained nearly 40 pounds of nitrogen, over 10 pounds of phosphoric acid and over 14 pounds of potash per acre. When the crop is allowed to mature the potash in the roots and stubble is increased, but the nitrogen and phosphoric acid is reduced. This crop can be used in connection with small fruits as well as with peaches, pears and apples."

(See also U. S. Dept. Agr., Div. Agros. Circ. 17; Div. Bot. Circ. 18; N. J. Expt. Sta. Bul. 100; Mich. Expt. Sta. Bul. 125.)

Alsike Clover (*Trifolium hybridum*) [also called Swedish clover]—This is a forage plant intermediate in appearance between common red clover and white clover. The blossom is pinkish-white, and the plant attains a hight of 12 to 24 inches. It is a perennial and thrives best in a cool climate. It yields less than red clover and produces but little aftermath. It will grow in moister soils than red clover, but is not so resistant against drouth. The seed are about half the size of red clover seed. About 15 pounds are required to seed an acre. Alsike makes a fair pasture crop when sown with the grasses. The Michigan Station recommends it for the light sandy soils of that State. Where red clover will thrive alsike will be found of only minor importance, except as a part of a grass mixture.

In feeding experiments with alsike at the Montana Station with lambs it has given better results than either alfalfa or red clover. Five acres of alsike under irrigation at the same station furnished pasture to 18 steers and heifers for 102 days, during which period the animals gained 4560 pounds of flesh, worth $182.40. This is a return for the land of $36.19 per acre.

Alsike hay is finer than clover or alfalfa hay, since the plants grow more closely together. It is, however, more difficult to cut and cure when grown alone. The Montana Station states that it produces phenomenally under irrigation in that State and may be grown under conditions not suited to either red clover or alfalfa. When mixed with red clover it improves the quality of the latter and is excellent in pastures, providing some water is supplied. It also withstands freezing well. (For composition see *Appendix*.)

White Clover (*Trifolium repens*)—This is a low creeping ~~perennial~~ with a white bloom, and is suitable only for pasture. It is not largely sown, but finds its way into meadows and pastures where conditions are favorable. The seed are much smaller than red clover seed. Ten to 12 pounds are sufficient to seed an acre. Usually it should form part of a general mixture. It is especially suited to grow with bluegrass. It is an excellent bee plant and valuable in lawns. The seed yield is from 200 to 300 pounds per acre. (For composition see *Appendix*.)

Enemies: STEM ROT (*Sclerotinia trifoliorum*) attacks clovers, alfalfa, sainfoin and related crops. Irregular swellings appear on the stem near the crown. The leaves are also attacked, are covered by a fine fungous felt and die. The disease may be carried from place to place on affected plants. Infected ground should not be planted to clover for 2 or 3 years.

LEAF SPOT (*Phyllachora trifolii*) causes small circular black specks on the under side of the leaves. From above the spots appear light green.

RUST (*Uromyces trifolii*) appears as small dark spots on the leaves. The spots are composed of a red powder. The last 2 diseases are seldom of much importance, but may be largely prevented by rotation of crops. (For dodder see under *Alfalfa*.)

CLOVER SEED MIDGE (*Cecidomyia leguminicola*) appears in May or June at the flowering time of red clover. The eggs are laid in the clover heads and hatch into yellow or orange maggots, which ultimately penetrate into the developing seeds. There are probably 2 broods per year, and the adults are minute flies slightly resembling mosquitoes in appearance. Early cutting of the first crop will partly prevent the development of the young midges. Badly infested fields may be plowed under.

Clover Hay Worm (*Pyralis costalis*) is the larva of a brown or purple colored moth, ¾ of an inch across the wings. The wings are marked with yellow spots and lines. The eggs are deposited in the hay and soon hatch into brown caterpillars, which feed in the hay, spinning silken threads wherever they go. This insect usually does not occur in great numbers, except where clover hay is held over for 2 years. If the hay is fed in the spring, the damage from the clover hay worm is much reduced. The bottom of badly infested stacks or mows should be destroyed. Where hay mows are constructed so as to be nearly airtight, they may be fumigated with bisulphid of carbon.

Clover Leaf Midge (*Cecidomyia trifolii*) closely resembles the clover seed midge. The larvae are not so long and are paler in color. The insect attacks the leaf rather than the seed, producing a peculiar folding of the leaf which resembles galls. The leaf substance becomes thickened and yellow or spotted with brown. This species is often abundant, but seldom causes serious damage.

Clover Root Borer (*Hylastes obscurus*) is a beetle about ⅛ of an inch long, of a brown or black color. The eggs are laid in May and June in small cavities in the roots, which are gouged out by the female beetle. There is 1 brood per year. The young grubs feed in the large roots and burrow downward toward the branches of the roots. No direct insecticides can be applied against this species. The best preventive remedy which has been suggested consists in plowing infested fields in June and thus exposing the grubs to the sun's rays.

Clover Leaf Weevil (*Phytonomus punctatus*) is a snout beetle which was introduced from Europe, and has caused considerable injury to clover in many parts of this country. The insect passes the winter in the larval condition in the soil. The beetles appear in greatest numbers in July and August and feed upon the leaves. The larvae also feed upon the leaves, but are less injurious than the beetles. This insect is usually held in check by a fungous disease to which it is very susceptible.

Clover Stem Borer (*Languria mozardi*) is a beetle ¼ of an inch long, with yellow thorax and black wing covers. The eggs are laid in June in the stems of clover plants. The young grubs upon hatching burrow downward into the stem. There is only 1 brood per year. This insect lives also in a number of weeds and other plants, especially in knot-weeds. The insect will usually be held in check by cutting the clover at the 2 regular seasons, being careful not to leave clover plants standing in fence corners or out-of-the-way places. Such neglected plants may serve as feeding places for the borer.

Clover Mite (*Bryobia pratensis*) is a red mite somewhat larger than the red spider of greenhouses, which infests the leaves of clover or other plants, including trees, causing the leaves to turn yellow. The clover mite feeds especially upon the upper side of the leaves. Eggs are usually laid on the bark of trees and sometimes deposited in such numbers as to give the bark a reddish color. Occasionally these mites wander into houses in large numbers and become a nuisance. This migration of the mite from its host plant usually occurs in the fall, when it is seeking hibernating quarters. The eggs may be destroyed on fruit trees by spraying with kerosene emulsion. The entrance of the mites into houses may be prevented by spraying with pure kerosene or kerosene emulsion.

Clover Seed Caterpillar (*Grapholitha interstinctana*) is the larva of a minute brown or black moth, with a wing expanse of 1-3 inch. The moths bear silvery white lines on the hind border of the forewings. The caterpillar is pale green, with a brown head, and injures clover by eating into the young heads, causing them to dry up and to shed the flowers. The moths appear during the first half of May and from 3 to 5 caterpillars infest each head. In combating this insect it has been recommended that a narrow strip of clover be left at intervals through the field, and after the eggs of this insect have been deposited this clover may be destroyed.

Clover is attacked by about 200 species of insects besides those already mentioned. Blister beetles, wireworms, locusts, white grubs, cutworms and leafhoppers sometimes are serious cause of damage to clover crops. (See *Index* for these insects.)

CORN (*Zea mays*)—(See also *Pop Corn, Sweet Corn*)

Corn is more extensively grown in the United States than any other grain, the acreage being about double, and the product 4 times greater than wheat. It is a staple crop in every State and Territory of the Union except Alaska and grows under widely varying conditions of soil and climate. More experimental work has been carried on with corn at the Agricultural Experiment Stations than with any other farm crop, and all the more important cultural facts have been pretty definitely worked out.

Soil—The rich, friable loams of the central Mississippi States are the ideal corn lands of the country, and these States furnish the bulk of the corn crop. Good crops, however, can be obtained on a variety of soils varying from the lighter sandy loams to heavy clays. When a choice can be had a warm, porous, well-drained loam should be chosen. Corn is a rank grower and succeeds better under unfavorable soil conditions than most farm crops. This is due to the remarkably strong root system of the plant. Within 60 days from planting, corn roots have been traced 8 feet deep and as far laterally. The main bulk of roots, however, has been found to develop within 8 inches of the surface of the ground. Within this area a dense network of feeding rootlets reaching from row to row and completely permeating the whole soil area below the cultivated portion is formed. In investigations at the Utah Station it was found that the fourth inch of soil contains a larger amount of roots than the 3 inches above it or the 4 inches below it, and nearly as much as both together.

Plowing and Cultivating—Thin soil should be plowed shallow. On good soils depth of plowing seems to have but little influence on the crop. Plowing 5 to 7 inches deep is usual and is recommended. Subsoiling for corn is not a profitable practice. Corn should be cultivated about once every week or 10 days, and especially after every rain, in order to break up the crust and preserve a dust mulch. Begin soon after the seed is sown and continue the cultivation until the stalks are nearly as high as a man's head. A light spike-tooth harrow can be run over the field until the plants are 6 inches high, after which a cultivator which will run between or straddle the rows should be used. The essential thing in corn cultivation is to keep the ground free from weeds and covered with a soil mulch. The results of 56 tests at 17 different Agricultural Experiment Stations show an average increase of 42 per cent resulting from shallow cultivation as compared with deep cultivation. In moist years cultivation is of less importance than in dry years. It has been determined definitely that cultivation conserves soil moisture and makes the ground warmer.

Fig. 23—THE LAST CULTIVATION OF CORN

At the Wisconsin Station cultivation 3 inches deep left the ground more moist below the cultivated layer than cultivation 1½ inches deep, and these results have been in the main confirmed by similar experiments at the Utah Station. If we base methods of corn cultivation on the root development of corn it would seem that level cultivation 2 to 3 inches deep is most logical, and this depth is favored by most all the experiment stations. The kind of implement used in the cultivation of corn is not of so much importance as thoroughness and carefulness in using it. The last cultivation of corn is seen in Fig. 23.

Planting—The time for planting corn will, of course, vary with the locality and with weather conditions. From Southern Michigan west to Iowa and south to Kansas plantings between the 1st and 15th of May have generally given the best results. The rule should be to plant just as soon as danger from frost is past, and the earlier thereafter the better. From 2 to 3 inches is considered the best depth for planting corn.

Experiments thus far made indicate that where corn is grown for grain closer planting is more usual in the Northern than in the Southern States. At the stations in Alabama, Georgia, Louisiana and South Carolina, rows from 4 to 5 feet apart, with stalks at intervals of 3 to 4 feet, are preferred; while at other stations making such tests rows from 3 to 3 2-3 feet apart, with kernels 9 to 16 inches distant in the rows, have given the best average results. With the closer planting occur larger total yields, larger yields of grain, smaller ears, and more nubbins. If the corn is grown for grain the husking of the increased number of smaller ears increases the cost of the harvest; but if the corn is grown for silage and the grain ensiled with the stalks, the smaller ears are no disadvantage. Rows about 40 inches distant, with single stalks 3 to 9 inches apart in the row, are considered the best distance for silage corn at the Pennsylvania and Michigan Stations. There is practically no difference in the results whether corn is planted in hills or drills; convenience in planting and cultivating being the chief factors for consideration. The total number of stalks per acre influences the yields rather than their method of distribution. When planted in hills at the Illinois Station, 4 kernels in hills 3 feet 8 inches apart each way gave the largest yields of grain.

The length of the growing period of corn varies much. On the northern borders of the corn belt some small flint varieties develop in 70 days, and dent corns if grown at all mature only sufficiently for silage. In the Southern States, where dent corns are grown almost exclusively, the growing period averages 150 days. In the latitude of Illinois 100 days may be considered the minimum for field corn to fully mature, while later varieties often require 150 days.

Seed—The general belief that seed corn obtained from other soils or more northern localities is better than home-grown seed has not been substantiated by experiments in Alabama, Arkansas, Indiana, Maryland, or Oklahoma. On the other hand, the experiments at these stations clearly show the desirability of using only corn for seed which has been grown in the same latitude and preferably in the same neighborhood where it is to be planted. At the Michigan Station fully matured seed increased the yield over 11 per cent as compared with seed not fully matured. In a recent report from the Wisconsin Station it is shown that in experiments extending over a period of 5 years with a variety of flint corn very immature seed gave smaller yields of corn and stalks and slightly earlier maturity than fully matured seed. The largest yield of corn and stalks, however, was from corn gathered slightly immature. On the whole, it would seem best for every farmer to use mature seed corn grown on his own farm, or at least in his own neighborhood. This should be selected in the field, the best ears from the most productive stalks being taken. Seed corn should be stored in a dry place over winter away from the mice.

A large number of stations have tested the relative merits of kernels from the butt, middle and tips of the ear for seed. The average yield of corn for 9 years at the Ohio Station grown from butt kernels was 58.86 bushels, middle kernels 59.27 bushels, and tip kernels 58.70 bushels per acre. Experiments at Kansas for 5 years show very similar results. Where planting is done by machinery the grain will be more uniform if selected from the middle portions of the ear. This seems to be the only practical advantage of selecting the seed from the different portions of the ear.

Stripping, Topping and Detasseling—Sometimes the leaves are stripped off the stalks while the crop is growing and used for fodder. This practice reduces the yield of corn, and it is doubtful whether the fodder thus obtained will pay for the trouble of gathering it. Cutting off the tops above the ears when in good condition for fodder has in some cases decreased the yields, and in others it has not. In 20 detasseling experiments at 10 different stations the crop was increased in 7 instances, decreased in 8 and in 5 no effect was noted. In general it may be stated that the increased yields obtained by detasseling are so slight that the practice is of doubtful benefit.

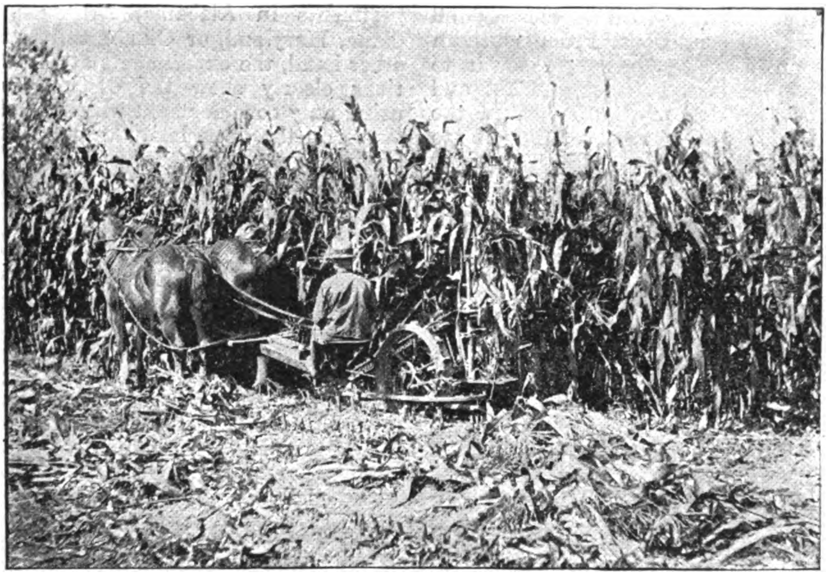


Fig. 24—CUTTING CORN BY MACHINERY AT THE CANADA EXPERIMENTAL FARMS

Manuring—Experiments in manuring corn have been carried out at nearly all the experiment stations and with a vast number of different fertilizers and combinations. The results secured are as variable as the soils upon which the corn was planted and the manures used. In a general way it may be stated that barnyard manure is one of the most effective fertilizers for corn. In some of the newer Western States all forms of fertilizers have been used without benefit, but in the Eastern States better results are obtained by the use of some fertilizer. Complete fertilizers containing phosphoric acid, combined with nitrogen and small amounts of potash, are most likely to give good results. Corn is a rank growing plant and its extensive root system and comparatively long growing period permits the use of coarse manures. Corn does especially well when grown after such crops as clover, peas, alfalfa, crimson clover, melilotus and other similar leguminous crops.

On the farm the corn field is a good place to put the coarse stable manures that have to be hauled out before they become rotted. The manure should be plowed under. The long growing season of the corn will enable it to utilize the manures as they slowly decompose, and the large amount of weed seeds which the manure contains will germinate and be destroyed by the thorough cultivation of the corn, thus furnishing a clean seedbed for a grain or grass crop which may follow. Cotton seed for heavy lands and cottonseed meal for light lands is quite generally recommended throughout the South.

Harvesting—Numerous experiments have shown that the dry matter in the corn plant increases as maturity approaches, and that, therefore, whether the crop is grown for grain, fodder, or silage, much will be lost by too early cutting. On the other hand, stalks allowed to stand in the field after ripening lose considerable dry matter. At the

Iowa Station this loss 2 months after ripening under ordinary field conditions amounted to about one-half of the dry matter and more than one-half of the total feeding value. According to the same authority, "the *stover* of a crop of corn seems to reach the highest yield and the best condition for feeding at the stage of growth indicated by a well-dented kernel and the first drying of the blades. The *grain* of a crop of corn seems to reach the highest yield and the best condition for utility at the stage of growth indicated by a well-ripened ear and a few dry blades; and the best time for securing the crop with reference to the highest utility of both corn and stover would be found at a stage of ripening between the above."

At the Kansas Station corn cut in the milk stage yielded 35.5 bushels of grain and 2.4 tons of fodder per acre; in the dough, 51 bushels of grain and 2.4 tons of fodder; when ripe, 74 bushels of grain and 2.7 tons of fodder. These results agreed with those of previous experiments. They have been in the main confirmed by similar experiments at the Illinois, Minnesota, New York, New Hampshire and Pennsylvania Stations. The Wisconsin Station recommends the cutting of flint varieties for silage when just past glazing and dent varieties when "well dented"; while the Vermont Station recommends that corn be allowed to stand before ripening as long as it is safe from frost. The Ohio Station found there was little difference in the yield of grain between corn cut and shocked, provided it was sufficiently matured at cutting time, and that left standing.

In the field-curing of corn at the Colorado Station, large shocks lost 31 per cent of their dry matter, small shocks 43 and corn spread on the ground 55 per cent—largely caused by the active fermentation in the seemingly dry and well-cured stalks. At the Oklahoma Station the outside stalks of corn shocks exposed to sun, rain, and wind lost fully one-fourth of their feeding value as compared with the inner stalks. The average loss in dry matter at the Wisconsin Station in ensiling corn was 15.6 per cent and in field-curing the same fodder 23.8 per cent.

To sum up, harvest corn for both grain and stover soon after the kernels are well dented and the blades begin to dry; but before the ears are thoroughly ripened. For silage, harvest flint varieties when just past glazing and dent varieties when well dented. A scene of cutting corn at the Canada Experimental Farms is shown in Fig. 24.

Varieties—There are 2 main classes of field corn, viz., dent corns and flint corns. (Figs. 25 and 26.) The kernels of dent corn generally have a wedge shape and are indented on the top. Flint kernels are hard, smooth and more or less oval without indentation on the top. Practically only dent corns are grown in the Southern States. Dent varieties usually give heavier yields than flint varieties; but the flint varieties develop more rapidly than dent corns, the stalks are less woody and are thus more completely eaten up by stock, and the crop is more certain to mature in the short summers of the more northern districts. It is more easily handled, and in Maine and Minnesota is preferred for silage purposes. Flint corn when planted in the South gradually takes on the characteristics of the dent corns. There are white and

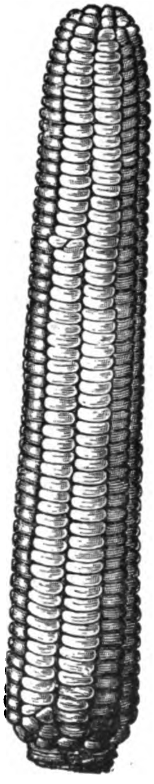


Fig. 25—
FLINT CORN

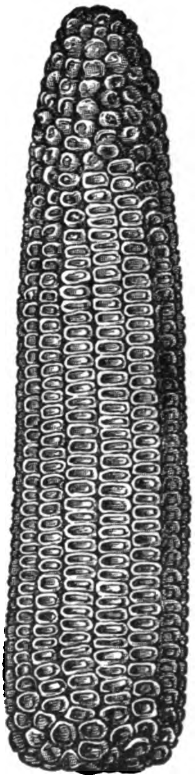


Fig. 26—
DENT CORN

yellow varieties of dent corn. They have exactly the same feeding value, and, taking the averages of many varieties of each, yield about equally well.

According to the Mississippi Station, the summarized results of tests of 490 varieties in 7 different States show the average yield of 217 white varieties to be 2½ bushels more per acre than the average yield of 273 yellow varieties. Not much information can be given as to the best varieties of corn to grow. The yield of the same variety varies greatly in different soils and localities. It will be best always to grow that variety which has given good results in the neighborhood and to test new varieties only on a small scale until their worth has been proved. In this connection it is well to note that varieties of corn cross readily, and in testing a new variety it should be planted in a separate field away from other varieties.

Some standard varieties of corn which have oftenest given the best results at the experiment stations are as follows: Dent varieties: *Yellow*—Leaming, Champion Yellow Dent, Golden Beauty, Nickle Plate, Murdock, Riley Favorite. *White*—Cocke Prolific, Blount Prolific, Burr White, Calhoun Red Cob, Mosby Prolific, Welborn Conscience, Boone County White and Shaw Improved. Flint varieties—King Phillip, White Flint, North Dakota, Will Gehu.

Rotation—Corn enters into nearly all American farm rotations. For general farming outside the cotton belt a good 4-year rotation is as follows: First year, corn; second year, oats; third year, wheat seeded with grasses in the fall and clover in the spring; fourth year, clover and grass. The coarse barnyard manures should be applied to the corn crop, which is best able to use them. In the Southern States corn, cowpeas, cotton and small grains enter into the rotation in a number of different combinations. The Alabama Station recommends a 3-year rotation as follows: "First year, corn with cowpeas between the rows, if the land produces less than 20 bushels of corn per acre, followed by winter oats; second year, winter oats, followed by cowpeas; third year, cotton."

Feeding Value of Grain—Corn grain is relished by all farm animals. On account of its high starch and oil content it is pre-eminently adapted for fattening purposes and stands at the head of the list of grains for this purpose. In fattening cattle or hogs or for feeding to milch cows producing a heavy flow of milk the grain is somewhat more effective if ground, since in this form it is most easily and completely digested. It is not necessary to grind the grain for sheep worth feeding, and to horses it should be fed whole. Corn is not quite as good a grain feed for horses as oats on account of its tendency to produce fat. Foreign experiments go to show that it may, however, constitute one-third of the grain ration where oats make up the other two-thirds, and at a less cost and with as good results as where the whole grain ration is made up of oats.

In the corn growing districts of the West it is the common practice of feeders to give fattening steers unhusked corn. The stalks with the ears are thrown in racks, from which the steers pick out the grain and such portion of the fodder as is palatable. Shoats are allowed to run with the steers and pick up whatever shelled and undigested kernels there may be. While this seems like a wasteful practice it possesses the advantage of cheapness, and the unhusked grain is preserved in a fresh and especially palatable condition. Prof. Henry of Wisconsin is of the opinion that where corn is cheap, as in the central corn belt, this is the most economical method of feeding it to steers. Cattle may just as well husk their own corn as to pay a round price for having it done by hand labor or machinery. It requires on an average a little more than a thousand pounds of grain to give 100 pounds of gain in flesh with steers. Where the ears of corn are large or especially hard and dry some mechanical treatment is very desirable. As noted before, the ground grain is especially valuable; but it is a concentrated food and must be fed with care or the animals are liable to get off feed. Especially is this true in the later stages of fattening, when the animals have a delicate appetite. Bran, ground cob, etc., should be fed with it. If grinding is not resorted to, soaking the corn in water until it begins to soften may be practiced with good results. The Kansas Station found that steers fed soaked corn gave larger gains on less grain than where fed dry corn. On the whole, there was a saving of 15 per cent by soaking the shelled corn. Large ears of corn should be broken up in the feed box with a hatchet. Or if the whole cobs, grain and all, with or without the husks, can be run through a crusher, so much the better. For milch cows corn should not form over one-half the grain ration; since for milk production, as for lean meat, grains richer in protein are required.

Corn is the most commonly used grain for hogs, but with young pigs, as with all other growing animals, it should not constitute the whole of the concentrated ration for a long period. Better quality and firmer meat and a larger proportion of lean may be obtained when it is fed with some more highly nitrogenous grain, as peas or barley. Unless too dry it may be fed whole. Very dry corn should be soaked. Corn meal should always be soaked when fed to hogs to increase its palatableness. The experiments in feeding hogs corn and cob meal vs. corn meal are somewhat conflicting, but practical experience is in favor of feeding the ground cob with the grain.

For sheep no grain excels corn, especially for fattening lambs. Numerous experiments go to show that it requires about 500 pounds of grain to produce 100 pounds of gain. Soaking corn for sheep is an undesirable practice. For a further account of the feeding value of corn see under each of the different farm animals and poultry. For the composition of corn and corn products see *Appendix*.

Fodder Corn—Corn fodder or fodder corn, as the term is generally applied, has reference to the whole corn plant, either dry or green, when grown for fodder, and includes the stalk, leaves and ears. Corn stover is the stalks and leaves without the grain. More than one-third of the feeding value of the corn plant is in the stover. Therefore much will be lost if this is not utilized. It is a common practice where corn is grown for grain to harvest the corn in shocks or stooks and husk out the grain by hand. When the grain is fed to steers or dairy cows this husking is a useless and expensive practice. The cattle rather do it themselves. Corn fodder which has been grown so thickly that the ears are scarcely half size is one of the very best fodders for horses, young cattle, dairy cows and steers in the first stages of fattening. Corn stover is, of course, less valuable, but for horses not at work and for the maintenance of cattle and sheep over winter it possesses much greater value than is usually ascribed to it. Especially is this true when the stalks are run through a shredder or feed cutter and the coarse stalks made more easy of mastication. A field of corn for fodder is seen in Fig. 27.

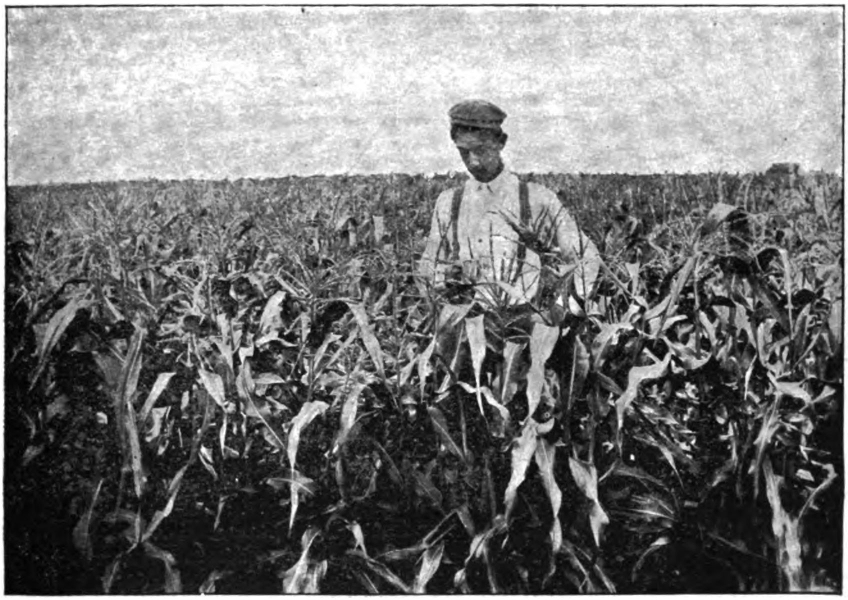


Fig. 27—SQUAW CORN FOR FODDER

New Use of Corn Fodder—Many new uses have lately arisen for corn pith, such as a packing for battleships, the production of cellulose, high explosives, varnishes, etc., and in its manufacture the outer shell and leaves of the stalk are left as by-products. These are finely ground up and put on the market as the "New Corn Product," which is used as a stock food. In experiments with steers at the Maryland Station this new corn product was found more digestible than whole fodder and very satisfactory as compared with corn blades.

For by-products of corn, such as gluten meal, cream gluten, corn germ, etc., see under *Feeding Farm Animals*. For the use of corn as silage see *Silage*. The above data on corn are taken in part from an article written by one of the authors for the Scientific American Supplement, Vol. 51, No. 1310.

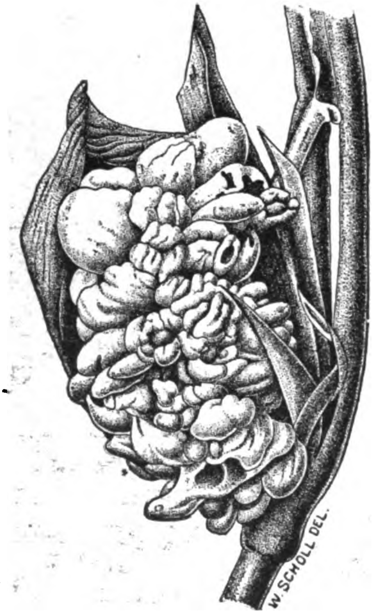

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Fig. 28—CORN SMUT

Literature—For a complete treatise on corn consult The Book of Corn, by Herbert Myrick, 1903. Methods of judging corn can best be learned by consulting The Manual of Corn Judging, by A. D. Shamel, 1903. For the botany of corn and descriptions of varieties see Varieties of Corn, by E. L. Sturtevant, U. S. Dept. Agr. Office Expt. Sta. Bul. 57. For methods of breeding corn to change its chemical composition see Improvement in the Chemical Composition of the Corn Kernel, by C. G. Hopkins, Ill. Expt. Sta. Bul. 55. Directions for corn culture in the South may be found in U. S. Dept. Agr. Farmers' Bul. 81.

Enemies: SMUT (*Ustilago maydis*) appears first on the leaves after the plant is about half grown. White wrinkles are produced in the leaves. Later the ear is attacked and becomes a mass of black powder, as seen in Fig. 28. In the ears the disease first appears as polished white tumors. No good remedy has been devised. Smutted corn should not be fed to stock, since infection may be spread through the manure. Treatment of seed corn is of no avail. Smutted ears should be collected and destroyed before the bursting and discharge of the spores.

A bacterial disease attacks corn plants of all ages, causing a sickly and yellow appearance, with death of the leaves and formation of a gelatinous substance on the inside of the sheaths. At first the disease appears in well defined areas, but later it becomes generally scattered throughout the field. Late in summer the leaf sheaths show brown spots, which may sometimes appear on the ears. No remedy has been found. The preventive measures recommended for smut may be adopted for this disease.

RUST (*Puccinia maydis*) appears as small pustules on the leaves, and resembles wheat rust. The pustules are yellow at first, but the later ones are nearly black. Usually the rust appears too late in the season to do great damage to corn.

BLIGHT (*Helminthosporium inconspicuum*) occurs as small pale areas, which increase in size until nearly the whole leaf is affected. Later the spots change to brown and are covered with a fine weft. The disease may be partly controlled by burning over the ground after harvest and rotation of crops.

WILT (*Pseudomonas Stewarti*) is most injurious to sweet corn, in which it sometimes causes a loss of from 20 to 40 per cent. Affected plants suddenly wilt and shrivel up at any stage of growth. If the stems are cut lengthwise the wood fiber appears as yellow streaks. Soil treatments with lime and sulphur are useless. The planting of resistant varieties is recommended.

More than 100 species of insects have been recorded as injurious to corn, but the majority of these pests are only occasionally or locally present in great numbers. Cutworms, army worms, chinch bugs and locusts are more or less injurious to corn during almost every year, For treatment of these pests, see under *Wheat, Cutworms* and *Locusts*. A corn plant infested by wireworms and click beetles is shown in Fig. 29.

Bollworm also attacks cotton, tomato and many other cultivated plants. In States where corn is one of the chief crops the insect is especially injurious to this plant. The caterpillars enter the silk end of the corn and live upon the kernels. The only remedies suggested for this insect on corn are hand-picking and catching moths by lantern traps or by poisoned bait consisting of molasses, vinegar and some arsenical poison. (See also under *Cotton.*)

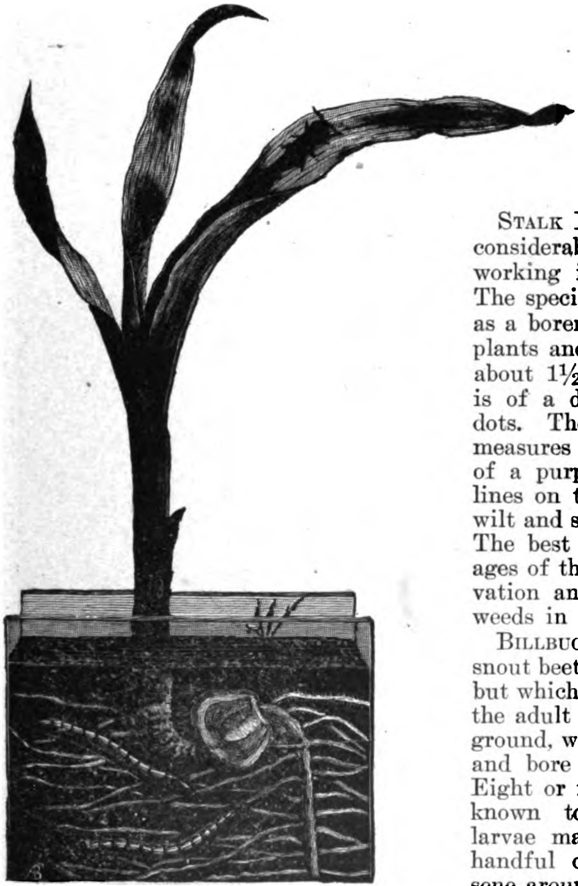

Fig. 29—A CORN PLANT GROWING IN A ROOT CAGE INFESTED BY WIREWORMS AND CLICK BEETLES
(From a specimen in the Cornell Insectary)

Corn Root-Worm (*Diabrotica longicornis*) is the larva of a small green beetle about ¼ of an inch long. The beetle appears in the fall on flowers of various plants. The eggs are deposited in October in fields on which corn is raised, and hatch during the second half of the following May. The larvae feed upon corn roots, into which they bore. This insect is not very injurious to other crops and its injuries may therefore be prevented largely by rotation of crops.

Corn Delphax (*D. maidis*) belongs to the family of bugs known as lantern flies, and is green or yellow in color, with black blotches on the head and yellow stripes along the side of the body. Eggs are laid on the midribs of the leaves and damage to corn is due to numerous punctures in the leaves. During the immature stages the insect lives protected within the sheaths. Spraying with kerosene emulsion will destroy many of the pests when present in large numbers.

Stalk Borer (*Gortyna nitela*) causes considerable damage to growing corn by working in the stalks and in the cob. The species ordinarily attracts attention as a borer in the pith of various garden plants and flowers. The moth measures about 1½ inches across the wings and is of a dark brown color, with yellow dots. The caterpillar when full grown measures somewhat over an inch and is of a purple brown color, with 3 white lines on the back. Infested stems soon wilt and should be cut out and destroyed. The best means of preventing the ravages of this insect consist in clean cultivation and a destruction of the native weeds in which it lives.

Billbugs (*Sphenophorus* spp.) are snout beetles which attack various plants, but which are most injurious to corn. In the adult stage the injury is done above ground, while the larvae attack the roots and bore into the center of the stem. Eight or more species of these bugs are known to attack Indian corn. The larvae may be destroyed by placing a handful of sand saturated with kerosene around each infected hill.

For other corn insects, see *Angoumois Grain Moth* under *Granary Insects, Wireworms, Rose Chafer* under *Grapes, White Grubs, Blister Beetles* and *Corn Aphis* under *Plant Lice.* (Nebraska State Bd. Agr. Rpt. 1891, p. 240.)

COTTON (*Gossypium* spp.)

This fiber plant is successfully cultivated in the United States as far north as Southern Virginia and Northern Oklahoma, and south into Texas and Florida. Within this area is included the cotton belt of America. Small amounts of cotton are also grown outside these limits in various scattered localities. The Mississippi River divides the cotton belt into 2 practically equal regions as regards production. Texas is the State of largest production, yielding 2,438,555 bales in 1900.

The plant belongs to the order *Malvaceae,* which also includes the vegetable okra and the hollyhocks of our old-fashioned gardens. Two species of cotton are grown in the Southern States, Upland or Short Staple cotton (*G. herbaceum*) and Sea Island cotton (*G. barbadense*). Cotton as grown in the South is a small annual shrub averaging 3 to 4 feet high and branching. "The flowers of Upland cotton are white or cream colored on the first day, become reddish on the second and fall on the third, leaving a small boll enveloped in the calyx. This boll develops until it reaches approximately the size and shape of a hen's egg, when it splits into 3 to 5 cells, liberating the numerous black seeds covered with the fibrous wool which constitutes the cotton of commerce."

Sea Island cotton is grown most extensively on the islands and along the coast of South Carolina and in Georgia and Florida. It yields less per acre than Upland cotton, but the lint sells for a higher price on account of its longer staple and better quality. The total production of cotton in the United States in 1899 to 1900 was 9,044,500 bales of 500 pounds each, and 98,338 bales of Sea Island cotton. The Sea Island cotton is thus seen to be of relatively small importance. Two-thirds of the Sea Island crop is produced in Georgia.

Practically every experiment station in the cotton growing States has published one or more bulletins on cotton culture. These bulletins contain valuable suggestions on cotton growing and can be obtained free of cost upon application to the directors of the various stations. (For addresses see *Agricultural Experiment Stations.*)

Planting and Cultivation—The cotton plant has a long, deep tap root, which enables it to withstand drouth well and to thrive better on poor land than most any other farm crop. Clay loams well drained and sandy loams resting upon clay are both highly recommended for cotton growing. Both should contain a fair amount of vegetable matter. The Louisiana Experiment Station states that—

"Deep and thorough preparation of soil, followed by pulverization, should always precede planting. The planting should be done by some of the excellent and cheap cotton planters now to be everywhere found, since only the machine will give that uniform and straight stand which so facilitates the subsequent chopping. It furthermore economizes the seed, a point of great importance, when the true value of this article as a manure and feed stuff is appreciated. The first plowing of cotton may be as deep and thorough as possible, but all subsequent workings ought to be as shallow as the character of the land will permit, since root-breaking to this plant is almost a disaster. After every heavy rain the soil should be stirred and during drouth a shallow implement run just deep enough to break the continuity of the pores of the soil and to form an upper layer, which shall act as a mulch to conserve the moisture of the soil, has often been found highly beneficial.

"Grass is an enemy of the cotton planter and should never be permitted (if possible to prevent) to obtain possession of his fields. In cotton, as in all other crops, the hoe should be used as little as possible. It is an element of cost excessive to bear, and with this plant often causes the disease known as 'sore shin' by breaking or removing the epidermis of the tender stalk in the effort of the hoemen to remove the last spire of grass.

"When to plant must be decided by the climate and by the character of the soil. When the ground is warm enough to promptly germinate the seed and give a vigorous healthy plant, then the seed can be wisely trusted in the earth. This is usually the case in this latitude in April. Planting in May is often hazardous, on account of the delay in germination, due to the prevalence of drouths at this period. When May planting is practiced the seed should be covered rather deeply and firmed with a light roller.

"A practice prevails among some of our progressive planters to plant late and highly fertilize. By this means they claim a crop of grass, which so frequently infests an early planting, is destroyed, the costly hoe labor avoided and the plant pushed quickly into vigor by the underlying fertilizer, soon occupies the ground and renders the after culture both simple and inexpensive. As a rule, it is best to plant poor, unfertilized lands early and rich or highly fertilized lands late."

At the Georgia Station rows 3 feet apart, with plants 2 feet distant in the row, have quite uniformly given heavier yields of seed cotton than any other combination of distances. The usual distance throughout the South is 4-foot rows, with single plants 12 to 14 inches apart in the row. At the Alabama Station Truitt cotton in 40-inch rows on upland of medium quality gave practically the same yields whether the single plants stood 12, 18 or 24 inches apart. The yield decreased when the distance between plants in the drill was increased to 30 or 36 inches. The crop also matured earlier with the thick planting. The yields obtained at the same stations by using fresh 1-year-old and 2-year-old seed were nearly identical. Topped cotton plants yielded less than those not topped.

At the Georgia Station the seed of Todd Improved, a large bolled rather late variety, was mixed and planted with Mascot, a small bolled very early variety, in the proportion of 5 pounds of Todd to 7 pounds of Mascot, which gave approximately the same number of seed of each kind. The resulting yield was considerably greater than when either variety was planted alone, and the practice is commended.

Fertilizing—The work of the experiment station is quite concordant in showing that phosphoric acid is the most important element in any fertilizer mixture for cotton. Next in importance is nitrogen, and finally potash. The best results have been secured when all 3 of these elements have been combined in one fertilizer in the proportion of about 3 1-3 parts phosphoric acid, 1 part nitrogen and 1 part potash; or in the proportion of 1000 pounds acid phosphate (14 per cent), 75 pounds of muriate of potash or 300 pounds of kainit, and 700 pounds of cottonseed meal or 105 bushels of cotton seed. The ingredients should be mixed and applied in such a manner as to secure from 200 to 400 pounds of the acid phosphate per acre.

Fig. 30—COTTON FIELD

Fertilizers for cotton may be either drilled in or broadcasted, and the results will be about the same by either method; but if the amount applied is small it should be applied in the drill, covered about 3 inches deep and the seed planted above it. Barnyard manures and similar bulky manures are considered more efficient as soil renovators than as specific fertilizers for cotton. They should be broadcasted liberally. The cowpea is a valuable and efficient crop in preparing the land for cotton. On plantations where the rotation is small grain, corn and cotton, cowpeas should be sown between the corn rows at the last cultivation, the seed harvested and the vines turned under or fed to stock, and the manure returned to the soil. The Mississippi Station states that to omit cowpeas from the rotation is an egregious blunder.

Harvesting—Machinery for picking cotton has not yet been perfected and hand-picking is usually practiced. This is the most expensive and tedious operation in cotton growing. The picking season averages 100 days and the fields have to be gone over from 2 to 4 times, according as the bolls come to maturity. There is a growing tendency to develop short staple varieties which open their bolls at nearly the same time. Negro labor is employed mostly in picking cotton and 100 pounds per day is a fair day's work. A cotton field is seen in Fig. 30.

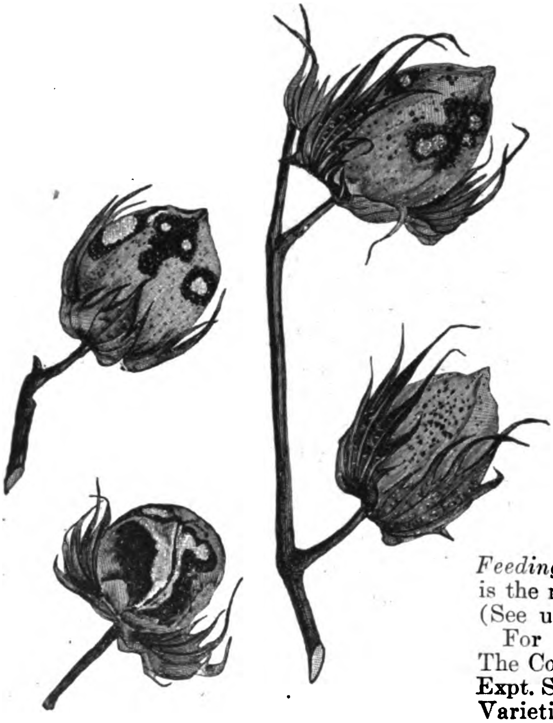

Fig. 31—COTTON ANTHRACNOSE

Varieties—Variety tests of cotton have been conducted at a number of stations. Some of the most satisfactory varieties reported from Georgia are Prize, Moss Improved, Schley and Russel Big Boll. Texas Storm Proof is the variety most largely grown in Oklahoma. Texas Oak, Griffin, Hawkins, Mell Cross, Peterkin, Truitt, etc., have led in variety tests in Alabama; while for Texas, the State of largest production, the 5 varieties making the largest average yields of seed cotton per acre during 3 years were Beck Big Boll, Dixon Improved, Peerless, Sure Fruit and Cochran Prolific.

Use—The use of cotton fiber in the manufacture of cotton cloth is too well known to require special mention. Cotton seed, long considered a waste product, is now used extensively in the production of cottonseed oil. With the improved machinery now in use from 40 to 45 gallons of oil are extracted from a ton of seed. The larger portion of this oil is used in the preparation of food products, principally refined lard and salad and cooking oils. The residue after the oil is extracted is a valuable fertilizer and feeding stuff. The hulls are an excellent fuel, furnishing ashes rich in potash and phosphoric acid. For the value of cotton seed, cottonseed meal and cotton hull ashes as fertilizers see under *Fertilizers.* For the use of cotton seed and cottonseed meal in feeding see under *Feeding Farm Animals.* Cottonseed meal is the most effective feeding stuff in use. (See under *Cattle, Sheep, Pigs.*)

For complete treatises on cotton see The Cotton Plant, U. S. Dept. Agr. Office Expt. Stas. Bul. 33; and Cotton: Its Uses, Varieties, Fiber, Structure, Cultivation, By-Products, etc., by C. P. Brooks, 1898. For the value and use of cotton seed and its products see U. S. Dept. Agr. Farmers' Bul. 36. For accounts of tests of varieties and other experimental work see publications issued by each of the experiment stations in the cotton growing states.

Enemies: ANTHRACNOSE (*Colletotrichum gossypii*) affects the bolls, stems and leaves. On the bolls the disease begins as small red spots or depressions, as seen in Fig. 31. The tissue blackens as the spots increase in size. The stems of seedlings are attacked near the surface of the ground, causing them to wilt and die. The fungus develops most readily on injured leaves. No satisfactory treatment is known.

Root Rot—See under *Alfalfa*.

Leaf Blight (*Sphaerella gossypina*) attacks chiefly the older leaves or those which show disturbances in nutrition. Reddish circular areas appear, surrounding light-colored areas. The leaves may become blackened with a fungous felt. No satisfactory treatment is known.

Mildew (*Ramularia areola*) affects definite areas of the leaves, limited by the small veins. The spots are covered with a white fungous weft, but appear yellow when seen from above. There is no satisfactory treatment.

Boll Rot (*Bacillus gossypinus*) affects the bolls, seeds and lint. The seeds are first affected and the whole contents of the boll may become rotten. The place and method by which the bacillus gains entrance to the plant are not well understood and no good treatment is known.

Root Galls (*Heterodera radicicola*) are due to a minute nematode worm which penetrates into the root tissues and causes irregular knots and swellings. The worms are of a white or yellow color, of minute size and threadlike form. Each female lays from 100 to 200 eggs, and there may be 7 or 8 generations per year. This worm attacks the roots of a great variety of field and greenhouse crops. For treatment see *Nematode Worms*.

Damping Off is also known as "sore shin," and appears as a shrunken, reddish brown area on the stems just below the surface of the ground. If the disease remains confined to the superficial tissue the plant may recover. Usually, affected plants fall over and die. Liming the soil and cultivation after rains so as to dry the surface layer quickly will assist in checking this disease.

Wilt (*Neocosmospora vasinfecta*) also known as "frenching," gains entrance to the wood tissue of the stems through the roots. The external symptoms of the disease are not always striking, but the plants are often dwarfed. On cutting open diseased stems the interior, especially the wood tissue, is brown instead of white, as in normal stems. The continued growth of the fungus may plug up the water ducts and thus shut off the supply from the leaves. It is recommended that seed be selected from healthy plants which have grown on infected ground and which are therefore resistant to the disease. Of Upland cotton the Jackson race is very resistant. Destruction of diseased plants and rotation of crops are important. It should be remembered that wilt affects also watermelon, cowpea and okra. A race of cowpea known as Little Iron is quite resistant to wilt and may be planted on infected soil.

Mosaic Disease, or yellow leaf blight, depends partly on uncongenial conditions of soil and weather and the attacks of a number of fungi. The leaves become mottled, turn yellow and fall off prematurely. Healthy, vigorous plants are seldom if ever attacked by this disease. When the vital processes in the plant are checked the parasitic fungi which cause the real damage may gain entrance. The best preventive measures against the mosaic disease consist in removing any unfavorable soil or other conditions. In some cases cultivation may be required to help retain the soil moisture, in other cases a better drainage system may be needed. Vegetable humus should be added to the soil by plowing under leguminous crops, and potash should be applied as a fertilizer.

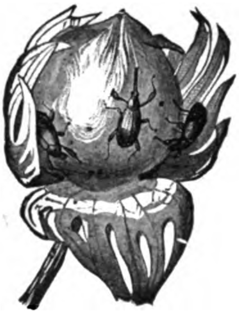

Fig. 32—MEXICAN BOLL WEEVIL

Red Rust is a reddening of the leaves caused by the attacks of the red spider. This trouble seldom affects whole fields. The mites increase in numbers most rapidly in warm, dry weather. For treatment see under *Citrus Fruits*.

Shedding of Bolls is apparently not due to either fungous or insect parasites, but depends upon unfavorable soil and weather conditions. Undue drouth or moisture or lack of proper fertilizers in the soil are predisposing causes. By choosing more resistant varieties and giving attention to soil conditions the trouble may be partly prevented.

Angular Leaf Spot first appears as watery spots in the leaves, in June or July. Later the spots show a black border. Great difference of opinion prevails as to the cause of the disease, but it is probably bacterial and may be carried by cotton insects, especially by cotton aphis.

As is apparent from this short account of cotton diseases, the subject is in a very unsatisfactory condition from a practical viewpoint. Much work must be done on these problems before practical and reliable remedies are discovered. (Ala. Sta. Buls. 36, 41, 55 and 107; Div. Veg. Phys. and Path. Buls. 17 and 27.)

Cotton is attacked by a number of insect pests, including cotton aphis (see under *Plant Lice*), locusts, various species of leaf-eating caterpillars and leaf hoppers. The 3 insects which have caused most damage to cotton are cotton worm, bollworm and Mexican boll weevil.

COTTON WORM (*Aletia argillacea*) is a blue-green caterpillar, with black spots and stripes on its back, and is found in the cotton fields throughout summer. It becomes most numerous and most injurious during the latter part of the season. There are several generations annually. The caterpillar, after becoming full grown, enters the ground, where it passes into a pupal stage. The moth is of an olive gray color, with an expanse of 1 to 1½ inches across the wings. It flies mostly at night. An extensive investigation of remedies for this insect was made by the United States Entomological Commission (see Fourth Report of this Commission, 1883-1885). The method of cultivating cotton is now somewhat different from the method in vogue when those investigations were made, and since the fields are more open, better opportunity is afforded for applying remedies when this process becomes necessary. The method most in vogue consists in the distribution of dry Paris green powder by means of 2 bags supported at the ends of a pole over the back of a mule. The bag may be made of heavy cloth, and when freshly filled a very slight amount of jarring shakes out a sufficient quantity of the powder, but when nearly empty the pole must be struck more vigorously.

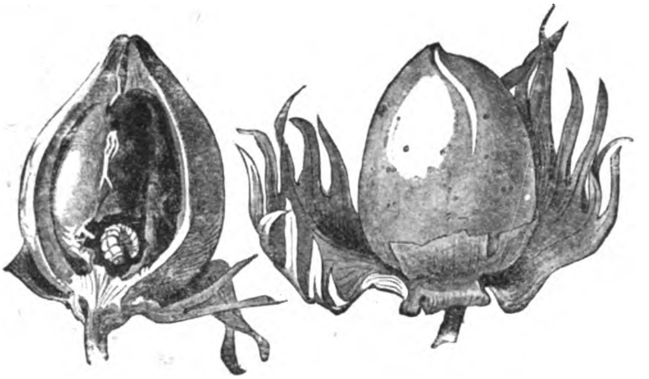
Fig. 33—BOLL SHOWING WORK OF WEEVIL

BOLLWORM (*Heliothis armigera*) (see also under *Corn* and *Tomato*) attacks a great variety of crops, but derives its name from its injuries to cotton. The caterpillar when first hatched resembles the cotton worm, but is somewhat darker in color. The eggs are laid on all parts of the cotton, but most abundantly on the under side of the leaves, and young caterpillars upon hatching travel in search of the bolls. When the bollworm enters a flower bud the envelope flares and the young boll finally drops off. The moth is yellow or olive green in color, and the 4 wings have a dark band at the tip; but there is great variation in the coloration and in the markings. The number of generations per year is about 5, and the bollworms hibernate in the pupal condition underground. In some parts of the South the lantern trap is used for catching moths with considerable success. Arsenical poisons may be successfully used for the third brood of cotton worm about August 1. In order to be effective the poison must be applied when the worms are seeking bolls. The most effective means of preventing damage from the bollworm consists in the proper handling of trap crops. A good trap crop is found in early sweet corn, which may be planted at intervals through the cotton fields, and as soon as the ears are seen to be infested they may be picked off and fed to stock or destroyed.

Mexican Cotton Boll Weevil (*Anthonomus grandis*) varies in size from 1/4 to 3/8 of an inch in length, is of a chocolate color, or occasionally almost black. The adult weevils feed during the day. In early spring they issue from winter quarters to feed on any young cotton to be found. In the fall the movements of the beetles are more sluggish. The egg is deposited in the young boll, and the larva upon hatching begins at once to feed on the inside of the boll.

No extensive migration of this species from one locality to another has ever been observed. The lantern traps are of little avail in fighting this weevil. Reliance should be placed on extermination by cultural methods. Trap crops of early cotton may be planted about gins and seed-houses, and these crops thoroughly sprayed with arsenical poisons for the destruction of the weevils in the spring. The weevils may also be jarred from the trap crops into pans containing kerosene or some adhesive substance. Infested squares may be recognized by their flared appearance and may be picked off and destroyed with the enclosed grubs. Many infested squares fall to the ground and may be gathered and burned or plowed under deeply. Since cotton seed is often infested with weevils, it may be well to fumigate it as it is ginned with carbon bisulphid, using 1 pound for 25 to 50 bushels of seed. Since cotton keeps growing and producing squares until severe frosts occur, it will be advantageous to allow cattle in the cotton fields late in the fall to eat the late squares which will be infested with the weevils. The remaining stalks may be cut down and piled in windrows, under which the weevils will hibernate, and this material may then be burned. Spraying may be adopted as supplementary to the cultural methods for combating this weevil. The arsenical poisons are recommended, a strong solution to be used for trap crops. (See also U. S. Dept. Agr. Farmers' Bul. 130.)

COWPEAS (*Vigna catjang*)

The cowpea is a leguminous plant grown for both forage and human consumption. In addition, it is one of the best soil renovators and improvers grown in the Southern States. The plant is sensitive to frost, but the earlier bush varieties are successfully grown as far north as Massachusetts and Wisconsin. It is, however, a crop pre-eminently adapted to the South, and plays there the same important role in agriculture that red clover does in the North and alfalfa in the West. As a soil renovating crop and also for forage its culture can be profitably extended to many localities farther north, especially to those sections where clover fails.

The cowpea is more of a bean in its botanical relations than a pea, being closely allied to the lablab, lima, and haricot beans of our gardens. It has been cultivated in the South for more than 150 years. The plant varies in habit from a compact upright bush-like plant a foot or more in hight to trailing vines 15 to 20 feet in length. When a trailing variety is carried northward from year to year it gradually assumes a bush form, and conversely a bush variety carried south soon becomes a trailing variety. This fact gives rise to a very large number of varieties. A leaf and pods are seen in Fig. 34.

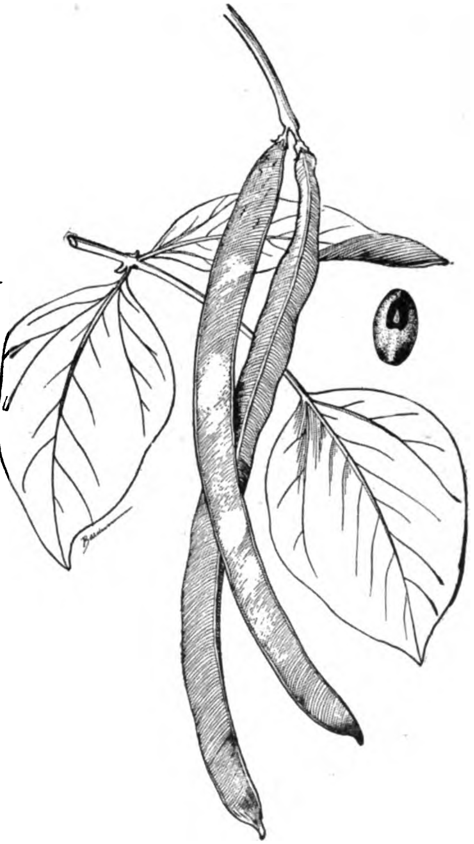

Fig. 34—COWPEA PODS, LEAVES AND SEED

The pods of different varieties vary from 4 to 16 inches in length, and the peas from large kidney shape to small round pea forms. The peas are of all colors, white, black, red, brown and intermediate shades, and are often mottled and speckled. A few varieties ripen seed in 60 days from time of planting, while others require from 8 to 9 months. Between these extremes there are all grades. In the Gulf States a yield of from 2 to 3 tons of cured hay per acre is common. Farther north the average will not exceed 1½ to 2 tons per acre. When the crop is grown between corn rows the yield of seed will average 8 to 12 bushels per acre, and when grown alone yields of 20 to 30 and sometimes over 40 bushels of seed per acre are common.

The advantages of growing cowpeas are briefly summarized by the Louisiana Experiment Station as follows: (1) The cowpea is a nitrogen gatherer; (2) it shades the soil in summer, keeping it in a condition most suitable to the most rapid nitrification and leaves it friable and loose and in the best condition for a future crop; (3) it has a large root development, and hence pumps up from great depths and large areas the water, and with it the mineral matter needed by the plant; (4) its adaptability to all kinds of soils, stiffest clays to most porous sands, fertile alluvial bottoms to barren uplands; (5) it stands the heat and sunshine of Southern summers; (6) its rapid growth enables the farmer in the South to grow 2 crops a year on the same soil; (7) when sown thickly it shades the soil effectually, smothering out all weeds, and thus serves as a cleansing crop; (8) it is the best preparatory crop known to the Southern farmer; every kind of crop grows well after it; (9) it furnishes a most excellent food in large quantities for both man and animals.

Seeding and Cultivation—The time and manner of growing cowpeas is conditioned upon several factors. If vines are wanted in the South the crop should be planted early; if seed is wanted later planting will give better results. The amount of seed to sow depends in a large measure on the size of the peas and whether they are sown broadcast or drilled in. Seeded broadcast from 1 bushel of the smaller to 2 bushels of the larger seeded varieties will be required; while if drilled in the amount will vary from 6 to 16 quarts. If the crop is planted early or on comparatively rich land a less amount of seed will be needed than for late plantings or on poor land. Experiments at the Georgia Station show that discolored peas are just as good for seed as any other.

The cowpea requires a warm, moist seedbed, and the peas rapidly rot if the seed is planted too early, while the ground is still cold and wet. This fact accounts for many failures reported from Northern States where attempts have been made to grow the cowpea. The ground for the crop should be plowed and harrowed until a good tilth is secured. When sown in drills the rows are made from 18 to 30 inches apart, depending on whether the smaller or larger varieties are grown. The seed should be covered about 2 inches deep. When the seed is drilled in the rows can be cultivated one way. As to the relative merits of drilling and broadcasting cowpeas, the Mississippi Station states that it has been its experience that the increase in yield of both seed and hay obtained when the cowpea was drilled in was more than sufficient to pay for the additional expense in drilling and cultivating the crop.

When the crop is sown broadcast and harrowed in it requires no further attention in the way of cultivation. It requires, however, a greater amount of seed, the growth of the plant is less vigorous, and the crop is not so easily cut if wanted for hay as when the seed is drilled in. When seed is plenty and labor scarce the general custom is to sow broadcast.

Fertilizing—It has been clearly shown by experiments at a number of stations that fertilizing the cowpea with nitrogenous fertilizers is not necessary nor profitable. This plant is able to secure all the nitrogen it requires for its growth from the air. (See *Leguminous Plants.*) It responds promptly to small applications of phosphoric acid and potash on most soils, but large applications have not been found to pay. The Georgia Station states that in the oak and hickory belt of that and adjoining States it is doubtful economy to supply even small amounts of potash. At the Delaware Station the use of 160 pounds of muriate of potash doubled the yield of vines, while superphosphate was without effect. In Georgia the best yields were obtained when superphosphate at the rate of 200 to 400 pounds per acre was used. Generally 100 to 150 pounds per acre will be found sufficient. Stated briefly, rules for fertilizing cowpeas may be formulated as follows: On soils devoid of vegetable matter use stable manure, cotton seed or other organic manures. On very light soil cottonseed meal is preferable to cotton seed and should be used at the rate of 150 to 200 pounds per acre as a top-dressing. On soils long under cultivation use 100 to 150 pounds of acid phosphate and about the same amount of muriate of potash, or the equivalent of these in some other form. Potash is not likely to be of much benefit on clay soils.

Harvesting—At the Georgia Station it was found that the best disposition of a crop of cowpeas was first to convert the vines into hay (or silage); and second, to permit the peas to ripen and gather (or pasture) them. "Mowing the vines and permitting them to lie on the surface and plowing under in November was decidedly better than turning the vines under in August." Turning the vines under green gave the poorest economic results of all.

Owing to the rank and succulent nature of cowpeas they are somewhat difficult to cure into hay. The vines are cut for this purpose when the first pods begin to ripen. The method of curing which has given good results in Mississippi is outlined by the experiment station as follows:

"The mower is started in the morning as soon as the dew is off, and run until noon, or until as much has been cut as can be handled in the afternoon. As soon as the top of the cut vines is well wilted the field is run over with a tedder to turn the vines over and expose them more thoroughly to the air and sun. When the crop is very heavy the tedder is used a second time, though this is seldom necessary. Vines which have been cut in the morning and tedded in the afternoon are usually dry enough to put into small cocks the next afternoon, and if the weather promises to be favorable they are left to remain in the cocks 2 or 3 days before they are hauled to the barn. If it should rain before the vines are put in cocks they are not touched until the surface is well dried off, and then tedded as though freshly cut. Those which are in cocks are not opened until well dried on the outside, and are then handled as little as is possible to secure a thorough airing. A light rain does very little damage to the hay, even after the curing has begun, if handled promptly and properly, and a heavy rain for a day or two may fall on freshly cut vines and do little or no damage. The essential point in making the hay is to do the work as rapidly as possible, and to avoid any handling of

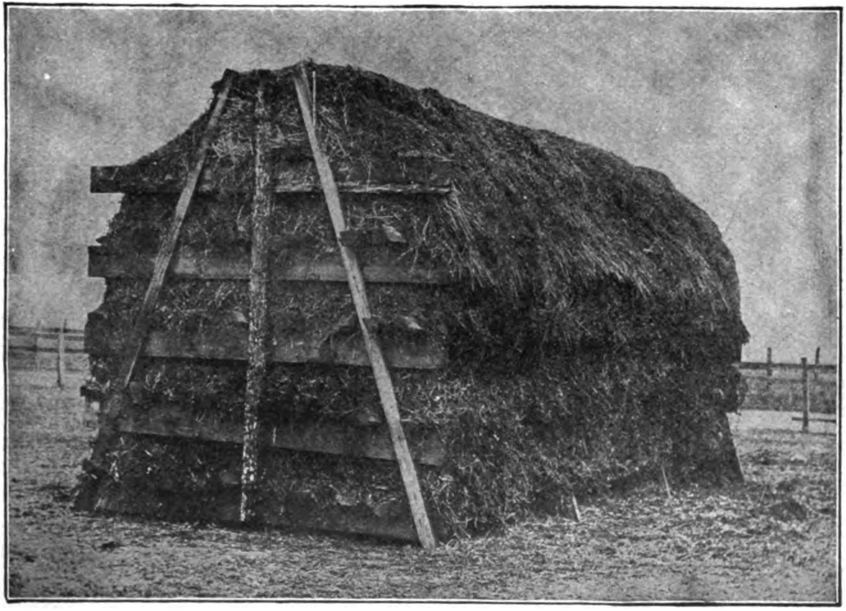

Fig. 35—STACK FRAME FOR CURING COWPEA HAY

the vines when wet with either dew or rain. We find that it pays well to use a tedder for stirring up the freshly cut vines so as to admit sun and air freely, though if a tedder cannot be had the work can be done nearly as well, though more slowly, by using a fork.

"It is not safe to bale the vines direct from the field. Of course that is the most convenient plan, but, as in many other cases, the quickest way is not the best. Although the field cured hay may appear and feel perfectly dry, it still contains a considerable amount of moisture, and if packed closely at once, it is sure to undergo a heating and fermentation, the escape of the heat and moisture is prevented, and decay is the result. We find the only safe plan is to put the hay, for a few weeks, into a stack covered with straw, or, still better, into a barn, where it should not be piled too deep. After a month it may be packed without danger of finding moldy or dusty hay in the centers of the bales."

Somewhat different from this is the method of curing advocated by Prof. W. F. Massey of the North Carolina Station. He advocates putting the hay into the barn when it has dried out enough so that if a handful of the vines is taken and twisted hard no juice runs out. When once in the barn the vines should not be disturbed, but allowed to heat and cure with as little contact with the air as possible. It is not necessary or advisable to rake the vines into windrows and cock. When cocked they are more liable to mold at the second handling in the barn. The vines should be simply left on the ground until they are in the half cured condition and then hauled in while still limp. Thus treated all the leaves are saved and a good green well cured hay secured.

The bush varieties are considered best for hay because of the greater ease with which they can be mowed and handled. A stack frame for curing cowpea vines has been devised by the Arkansas Station. (Fig. 35.) The frame is essentially a series of shelves made of poles or rails placed 12 inches apart and resting on horizontal supports 2 feet apart. The wilted pea vines are piled on the bottom rails 2 feet high; the second shelf of rails is then put on and more pea vines added, etc. Care is taken to keep the sides of the stack perpendicular, as the vines will not shed rain. The top of the stack should be covered with straw or something to turn water. Hay thus put up cured perfectly and was of a bright green color and of excellent quality. In using the hay take that from the lowest shelves first.

Cowpea seed is harvested by picking off the pods when they are ripe and threshing either with a flail or by machine. Sometimes the vines are run through a thresher, from which the concaves and the alternate teeth of the cylinder are removed; but this breaks and bruises many of the seed and is not generally practiced. Usually farmers gather only enough peas to seed the following season. Fully 95 per cent of the peas placed on the market are hand-picked.

Use as Green Manure—As noted above, the most economical way of using cowpeas is to feed the vines and peas to stock and return the manure to the soil. When this cannot be done the whole crop is often plowed under.

On heavy clay soils which need loosening the vines should be turned under green. The heavier the crop turned under the greater will be the beneficial action on the mechanical condition of the soil. On sandy soils which are already too light the vines should be grazed and left on the surface to decay. Where the vines are plowed under the operation should be done in the fall and the ground immediately followed by some winter growing crop, such as rye, wheat, winter oats or vetch. The roots of these growing plants catch and hold the foods liberated by the decaying vegetable matter in the soil and thus prevent winter leaching and washing. The following spring the green cover crop can be plowed under and the regular crop of corn, cotton or small grain grown. Where it is not practical to grow this winter cover crop it is best in practice to let the vines lie on the ground over winter. This prevents the washing and leaching of the soil that would occur on freshly plowed ground.

From analyses made at a number of experiment stations it has been clearly shown that an average crop of cowpeas turned under will add to the soil more than 110 pounds of nitrogen per acre, having an actual cash value of at least $14. Besides this direct addition to the soil of fertilizing material the crop renders available for the use of succeeding crops about 24 pounds of phosphoric acid and 100 pounds of potash.

Feeding Value—In a general way it may be stated that cowpea hay is about equal in feeding value to good clover or alfalfa hay. It is especially rich in blood, bone and muscle-making material. Hogs do especially well on cowpeas. An acre of ripening peas will pasture from 15 to 20 young hogs. Where it is intended to turn the vines under for green manuring it is advisable to first pasture with hogs. The droppings of the hogs will enrich the soil and a large amount of firm pork of excellent quality can be secured. Pigs also relish the cured hay, and it should be fed to fattening hogs in addition to the corn ration.

Cattle and sheep are liable to bloat if allowed to eat ravenously of the green vines; but if the vines are cut and allowed to wilt they may be fed all they will eat. The crop is especially good for soiling. Opinions differ as to the value of cowpeas for silage. It is generally regarded as inferior to corn as a silage crop, as it is much more liable to spoil.

In experiments with pigs at the Alabama Station cowpeas (grain) proved about equal to corn or to a mixture of corn and cowpeas 1:1, or to corn and wheat bran 1:1. Much more lean meat was produced on the cowpea ration, while the greatest amount of fat was found in pigs fed corn. In another experiment at the same station pigs fed corn and allowed to run in a cowpea field while the pods were maturing made considerably larger gains than pigs fed corn alone.

At the Delaware Station cowpea vine silage was successfully substituted for wheat bran in a ration fed to dairy cows. Seven pounds of silage were considered equivalent to one pound of bran. The usual flow of milk was maintained and the quality of the milk was considered excellent. In several instances it is reported that where bran was substituted for the silage a loss of 25 per cent in milk and butter fat occurred.

Varieties—From an extended study on varieties of cowpeas the Georgia Station makes the following recommendations:

1. The earliest cowpea, and hence the variety best adapted to high latitudes, is the *New Era;* this matures in a little more than 60 days from time of planting. Other very early varieties are *Congo, White Giant, Chocolate* and *Vacuum.*
2. The heaviest yielder of vines is *Red Ripper,* followed closely by *Forage* or *Shinny, Black* and *Unknown.*
3. The heaviest producers of peas are *Unknown, Calico, Clay* and *White Brown Hull.*
4. The yield of peas, as a rule, though not invariably, parallels the yield of vines.
5. For hay, the erect varieties are preferable to those of a recumbent habit, since the mowers cut them all. The best of the erect varieties are the *Unknown, Clay* and *Whippoorwill.*
6. Where a dense mass of vines is wanted to remain all winter on the ground, *Calico, Gourd, Black* and *Constitution* are preferable.
7. The best table peas are *Sugar Crowder, White Crowder, Mush, Large Lady, Small Lady* and *Rice.*
8. The best stock pea for field grazing of either cattle or hogs is the *Black.* It will remain in the ground all winter without injury. *Everlasting, Red* and *Red Ripper* are also good.
9. For an "all purpose" pea the *Unknown* leads the list. *Clay,* however closely contests first place. *Unknown* and *Wonderful* are identical.

Some of the more important bulletins on cowpeas are as follows: Ala. Expt. Sta. Buls. 118 and 120; Ark. Expt. Sta. Bul. 70, 77, 80; Mich. Expt. Sta. Bul. 199; Ga. Expt. Sta. Bul. 26; Miss. Expt. Sta. Bul. 40; La. Expt. Sta. Bul. 40, and U. S. Dept. Agr. Farmers' Bul. 89.

Enemies—Cowpeas are often attacked by weevils. For treatment see under *Peas* and *Beans.* For wilt disease see under *Cotton.*

DURRA (*Sorghum vulgare* var.)

This is a non-saccharine sorghum which is used as a forage crop. It is similar to Kafir corn and Milo maize. Indian millet and Egyptian corn are other names sometimes applied to it. Besides the use of the stalks and leaves as forage the grain is used as a stock food, and in some of the valleys of California is substituted for barley for horses. It is very similar in composition and feeding value to corn. (See *Appendix.*)

Where corn will do well there is no advantage in growing durra. Its chief advantages are its drouth-withstanding properties, and the fact that it will do better on poor land than corn. In periods of drouth the plant may make no growth. but pick up and grow again with rain where corn would be an entire failure. Durra grows from 4 to 8 or even 12 feet high, has sheathing leaves 2 inches broad and about 2½ feet long, and yields an abundance of grain in a broom-corn like head. It has been found most valuable in the semi-arid regions of the Southwest and West.

Experiments at the Kansas Station indicate that durra should be sown in drills 3 feet apart and the seed scattered 4 to 8 inches distant in the drill. It requires the same cultivation as corn. When the seeds become hard the crop should be cut and shocked. The whole plant may then be fed as forage in racks to stock. Much of the grain fed in this manner passes through the animals whole. For best results the heads should be cut off and threshed and the grain ground as fine as possible before feeding.

There are two varieties of durra, brown and white. At the Kansas Station brown durra (see Fig. 36) grew vigorously, producing from 5 to 10 full sized stalks from a single seed. The stalks were tall, coarse, jointed, with very heavy foliage and very juicy. A large percentage of the heads did not mature. The seed of brown durra is light yellow in color and slightly flattened. The heads are short, thick and heavy, hanging pendent on a short "goose-neck." The station advises that the heads be cut off before the stalks are cut if the seed has matured. This makes the handling of the crop much easier. One season the yield at the Kansas Station was 13½ tons of dry fodder and 40 bushels of seed per acre. Another season but 7 tons of dry fodder was secured and no grain. Owing to the late maturing habit of brown durra it is not considered by the station as good a substitute for corn as some other crops.

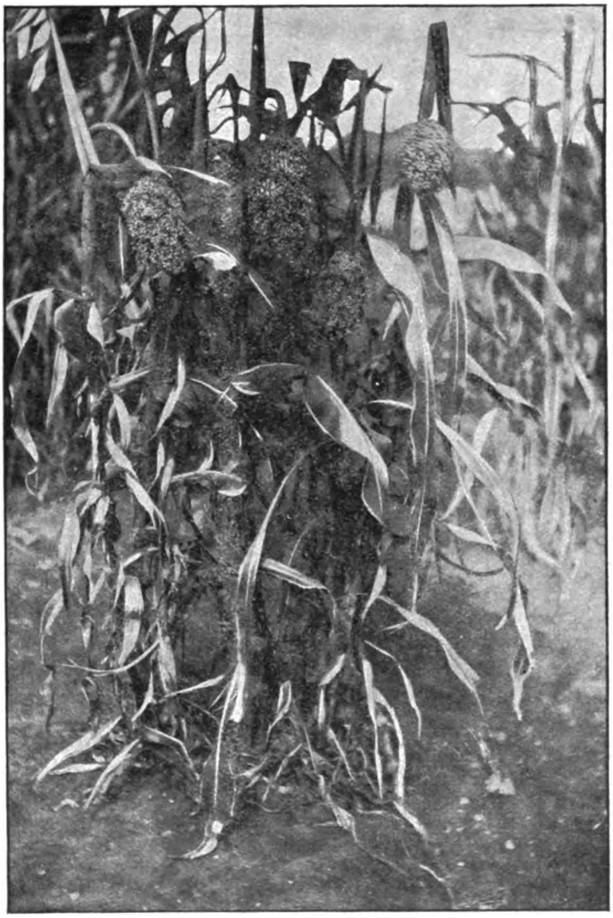

Fig. 36—BROWN DURRA

At the Wyoming Station brown durra matured seed in 123 days and yielded at the rate of 19,200 pounds of fodder per acre. It is recommended as a profitable forage crop for some portions of that State. At the New Mexico Station durra is reported to make 3 or 4 cuttings of good feed and is held as a reliable accession to the forage of the Territory.

White durra or Large African millet grows 8 to 10 feet high without suckers or shoots. The heads when well developed are 12 to 20 inches or more long. If the whole stalk is cut down and cured in shocks when the seed is in the dough state a very excellent forage is produced. Cut earlier in the season, a second crop sprouts up at once. The grain is white, with a pinkish tint, and weighs about 60 pounds per bushel. This variety matured at the Louisiana Station in from 90 to 100 days. The forage cured readily in 4 hours of sunshine. The crop yielded 12.54 tons of excellent hay and 43.16 bushels of seed per acre.

(See also La. Expt. Sta. Buls. 8 and 19, 2nd ser.; Kan. Expt. Sta. Bul. 18; N. M. Expt. Sta. Bul. 6; Wyo. Expt. Sta. Bul. 22.)

EGYPTIAN RICE CORN (*Sorghum vulgare* var.)

A non-saccharine sorghum forage plant similar to durra, but not so productive. The plant tillers very little, grows from 4 to 6 feet high, with but few leaves, and bears a plump, round seed head on a short "goose-neck" stem. The seeds are white, with black glumes, large and sweet. At the Louisiana Station it matured in July and August. It is cultivated like durra and used for the same purposes. It is suitable for green food and cures into good hay. The seed makes excellent feed, but shells out readily in handling and should therefore be cut before it is ripe. At the Kansas Station the yield one year was 3.47 tons of dry forage and 16½ bushels of clean seed. At the Louisiana Station the yield was 11 tons of hay and 22 bushels of seed per acre. At the Colorado Station the total yield was 4.1 tons of dry matter per acre. The Arizona Station reports it the best heat and drouth resistant plant of a number of forage crops tested. (Rpt. Expt. Sta. for 1900.) The English sparrow seems to have a special liking for the seed and practically destroyed 1 crop at the Kansas Station. (Kan. Expt. Sta. Bul. 18; La. Expt. Sta. Buls. 8 and 19; Col. Expt. Sta. Bul. 30.)

FLAT PEA (*Lathyrus sylvestris*)

A leguminous forage plant much resembling in appearance the common Sweet or Everlasting pea, as seen in Fig. 37. Where it succeeds it forms a rank tangled mass of vines 3 to 4 feet high and yields heavy crops. In favorable localities several cuttings are obtained each season, and a field once established will endure for years. The pea is hardy as far north as Canada.

The serious objection to it as a forage crop is that stock do not relish it. Both cattle and sheep lost flesh on rations of either flat pea hay or flat pea silage at the Michigan Station. It is very rich in protein, the air-dried hay analyzing about 27 per cent of protein. (See *Appendix.*)

The special value of the plant appears to be its ability to grow on light soils too poor and dry for clover or corn. An objection to it is that it requires 2 to 3 years to get it established. The seed may be planted in spring either in drills 18 inches apart in place or in a seedbed, and the seedlings transplanted in the spring of the second year. In light, dry soils the seed should be put in 2 to 3 inches deep, but shallower on heavier soils. During the first season the plants grow 8 to 12 inches, and should be kept free from weeds. The plants do not attain full vigor until the third season. The vines grow in such a tangled mass that they have to be cut with a scythe or sickle. The plant is perennial in the Gulf States, but is killed down each winter in the North.

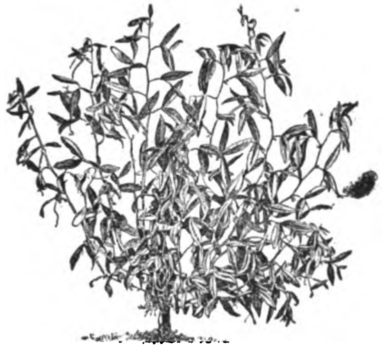

Fig. 37—FLAT PEA

The crop appears to be an excellent soil renovator. It may be found valuable where better forage crops cannot be grown, but experiments up to the present indicate that for forage purposes it is unsatisfactory.

FLAX (*Linum usitatissimum*)

This plant is both a fiber and seed crop. In the United States it is grown primarily for seed. Linseed oil, which is used so extensively in mixing paints, is extracted from the seed, and the residue makes a valuable stock food. Extended experiments by the United States Department of Agriculture have shown that the Northern States from Massachusetts west to Puget Sound are well adapted to the production of flax fiber and seed. Washington and Oregon have proved particularly well adapted for fiber production. Flax fiber from those States has proved equal to the best Belgian fiber. The yield of seed in the United States in 1899 was over 19,000,000 bushels, or nearly 30 per cent of the world's supply. Most of the crop is raised west of the Mississippi. At present, North Dakota, Minnesota and South Dakota, in the order named, are the States of largest production.

Soil and Fertilizers—A moist, deep, strong loam, well underdrained, is considered the best soil for both fiber and seed production. Good corn lands are the most satisfactory. Experiments at the Minnesota Station have shown, contrary to the usual belief, that flax is not so exhausting to the soil as either corn or oats. It is a dainty feeder, however, and absorbs most of the mineral fertilizers needed in its development during the first 45 or 50 days of its growth. For these reasons the soil for flax must be especially well prepared by deep plowing and working into a fine mellow seedbed in order that the food that the plant does require be in the best and most readily available form.

Nitrogen is the element most needed by the flax crop, and this can be best supplied by growing a crop of clover a season or so preceding the flax. Weeds, mixed with flax grown for fiber, greatly decrease its value, and on this account flax should follow some hoed crop or be planted on new or fallow land. For similar reasons barnyard manure should never be used directly on flax, but on some preceding crop.

Heretofore it has been impossible to grow flax on the same land year after year without the soil becoming "flax sick." The reasons for this have remained unknown until recently discovered by Prof. H. L. Bolley. He found that "flax sick soils" are caused by a fungous disease which is usually introduced into the soil through the seed. This disease, with methods of prevention, is described below under *Flax Wilt*.

Seeding—Flax seed is sown in the spring as soon as the weather settles and the ground begins to warm up. In the North this occurs sometime in May. When grown for seed 2 to 3 pecks are sown per acre. This gives room for the flax stalks to branch and produce many flowers and an abundance of seed. When fiber is wanted from 1½ to 2 bushels of seed are sown. With this thicker seeding the plants grow closer together, and instead of branching stalks but 1 straight stem is produced, from which a fiber of better quality is obtained. A crop is seldom grown for both seed and fiber at the same time, though this method is common in the best flax districts of foreign countries, the flax being pulled before the straw is too ripe and hard. Flax seed is usually sown broadcast by hand or with a broadcaster and seldom drilled in unless grown for seed. For seed, drilling will give very satisfactory results. When sown broadcast, the seed should be slightly harrowed in, followed on the lighter soils by the roller. Only seed of the best quality should be sown.

Where the ground is clean, the crop will require no attention, but if weeds are abundant in flax grown for fiber, they should be pulled out. The weeding should be done before the flax is 6 inches high or the harm to the flax by trampling and pulling will be greater than that done by the weeds.

Harvesting—Flax grown for seed should be harvested when the seeds are full and plump and of a good color. The best method of harvesting is with a binder. After the bundles are well cured out, they may be put in small stacks or stored in the barn until threshing time. The flax is threshed with a common grain threshing machine.

Flax grown for fiber is either pulled by hand or by machinery. The latter is the better way. (See Fig. 38.) Cut very low with a binder or reaper. The time for pulling is just as the straw is beginning to turn yellow and the lowermost leaves are beginning to drop. This will be in about 85 or 90 days after seeding. The pulled straw is tied up in small bundles or stooks and stood up with the tops tied together, and the bottoms well spread out to cure. (Fig. 38.) After the flax straw has cured, the next operation is to remove the seed. This is done by drawing the tops through special coarse combs, and also lately by the aid of the thresher. The concave is opened so that the teeth just come together. The heads of the stooks are then spread out fan-shape and presented to the machine. The operator keeps hold of the straw and draws it out as soon as the seed has all been knocked off.

Retting—The straw thus prepared is ready for retting. By retting is meant the dissolving by fermentation of the gummy substances which unite the outer fiber of the plant to the inner stem, so that the fiber can be easily separated from the worthless portion of the stem. This is done in several ways. Sometimes the straw is spread thinly on the grass, and thus left for about 3 weeks exposed to the dew and the rain and the moisture of the earth. A second method is to entirely submerge the straw either in tanks, pools or slow running streams. It requires from 8 to 14 days to ret straw by this method. Warm water in a tank was used for retting by the Washington Station. Water maintained at a temperature of 110° F. gave the best results. The retting by this method was completed in 110 hours. By this quicker method of retting more care must be taken not to overret the fiber. As soon as the woody stem breaks square off on being bent and the fiber slips readily from the stalk, retting is complete.

After retting the straw is dried and broken on a flax break and finally scutched, by which operation the fiber is freed entirely from the woody portions of the stem. As these operations belong to the manufacturer rather than the farmer, who has simply to grow and harvest the crop, they are not described in detail here.

Yield and Value of Flax—The yield of flax seed per acre varies from 8 to 15 bushels. The cost of growing and pulling a crop of flax fiber at the Oregon Station was $15.15, and for plowing, harrowing and sowing the seed $7.70. The price of flax seed per bushel varies from 85 cents to $1.50, and reached $1.86 in 1900.

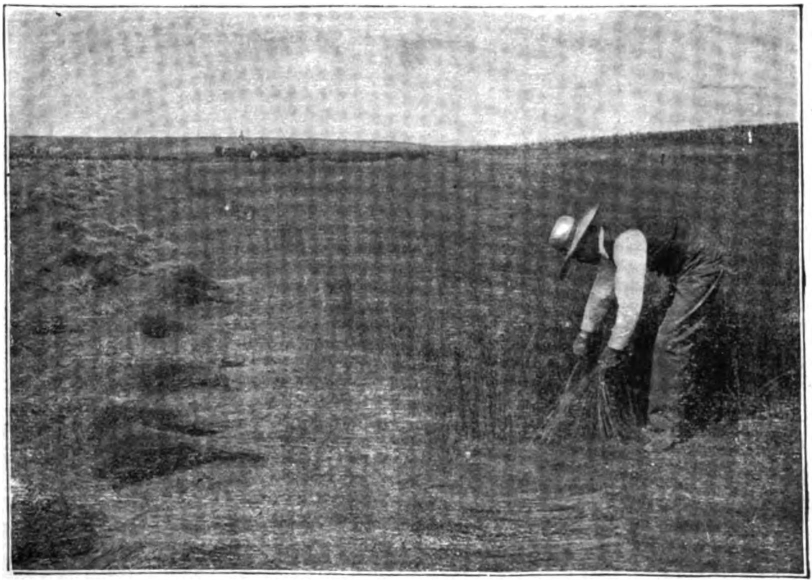

Fig. 38—HARVESTING FLAX
(U. S. Dept. Agr.)

Use of Seed and Hay—The chief use of flax seed is in the production of oil known in commerce as linseed oil. This oil has many uses, but is valued primarily for mixing with paints. The seed contains from 25 to 40 per cent of oil. The residue left after the oil is expressed is known as linseed meal, and is of great value in stock feeding (see *Feeding Farm Animals*), being rich in protein and quite thoroughly digested.

Flax is also cut just after blossoming and before seed development and used for hay. It makes a valuable fodder, being rich in protein and containing about the same amount of fiber as timothy hay. For composition of flax and its by-products see *Appendix.*

Varieties—There are several varieties of flax. White Blossom, Dutch, Riga and Belgian are among the best.

Literature—See also U. S. Dept. Agr. Farmers' Bul. 27; Minn. Expt. Sta. Buls. 13 and 47; N. D. Expt. Sta. Buls. 50 and 55; Ore. Expt. Sta. Bul. 54; Wash. Expt. Sta. Bul. 33; U. S. Dept. Agr. Office Fiber Inv., Rpt. No. 7.

Flax Wilt (*Fusarium lini*)—This is the fungous disease found by Bolley to be the cause of "flax-sick soil." It attacks plants at all stages of growth and they die early or late according to the time and intensity of the attack. If the soil is much infected the plants are killed before they reach the surface of the ground. When plants 2 to 5 inches high are attacked they wilt suddenly, dry up, and soon decay, if the weather is moist. Older, more woody plants assume a sickly, weak, yellowish appearance, wilt at the top, and slowly die. The roots of affected plants have a characteristic ashen-gray color. When nearly mature plants are attacked the gray colored rot may appear down one side of the tap root only. The leaves, side branches, and part of the main stem above this portion die, giving the plant a peculiar one-sided blight appearance. The fungus attacks the plants through the young tissues of the seed, leaves, stem or root. The disease is spread from one locality to another chiefly through infected seed, particles of soil, dirty implements, etc. Soil centers of infection in the field spread slowly and usually do not cover the whole field for 2 to 4 years, after which the soil is "flax sick" and further crops cannot be grown until after 5 or 6 years. No method of soil treatment except a rotation of 5 years between crops is known. The disease is usually introduced into the soil through the seed. This can be prevented by sprinkling the thoroughly cleaned seed with a solution of formalin, 1 pound in 45 gallons of water. The solution should be applied evenly and only enough to dampen the surface of the seeds, after which they should be shoveled over and over until dry. For a complete account of this disease see N. D. Expt. Sta. Bul. 50.*

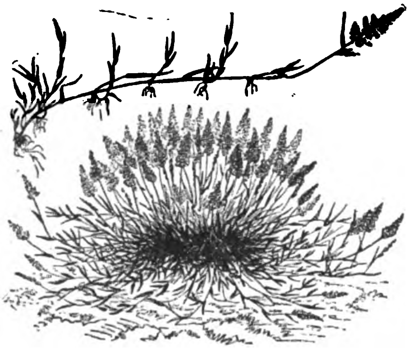

Fig. 39—CREEPING BENT GRASS

GRASSES

There is a vast number of grasses native and otherwise growing in this country which stock pasture upon; but the number of really important cultivated hay grasses scarcely exceeds half a dozen. East of the Mississippi, timothy is grown to the practical exclusion of all other hay grasses. Many farmers in this section know no other hay grass except as a weed. Next in importance as a hay grass is redtop or Rhode Island bent, which is also present in most meadows. Kentucky bluegrass or June grass, as it is sometimes called, is pre-eminently the cultivated pasture grass of the United States. Bermuda grass is extensively grown in the Gulf States. Other grasses that are much written about but less grown are orchard grass and the various fescues and brome grasses. These grasses and a number of others adapted to the dry regions of the West, lowlands, marshes, permanent meadows, etc., are noted in detail under separate headings below.

Grasses are seeded either with or without a nurse crop, sometimes alone, and sometimes mixed with other grasses. Timothy is quite generally grown with a small proportion of red clover added. These plants supplement each other well, since the timothy is a surface rooted plant, while the clover sends its roots down much deeper, bringing up plant food from the subsoil. The quality of the hay is also greatly improved by the addition of the clover. Grass mixtures are not generally advised where hay is grown for market. In permanent meadows and pastures, however, it is generally advisable to seed mixtures of a number of grasses to insure an abundance of herbage at all seasons of the year. (See *Meadows.*)

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*Recently Prof. Bolley has found that flax seed can be disinfected by subjecting it to formaldehyde gas. This prevents the swelling of the seed and makes it easier to handle.

Bent Grasses—These include the Rhode Island Bent (*Agrostis canina*), creeping bent (*A. stolonifera*), common redtop (*A. vulgaris*) and a number of other less well known grasses. All are very similar in habit of growth. They are perennials 2 to 3 feet high and grow from creeping rootstocks. The roots closely interlace and form one of the most dense sods known. The chief value of these grasses is for pasture, especially for dairy farming. They stand the trampling of stock well and are especially valuable for making good pastures in sandy, moist places where it is too marshy for other grasses. They may be overflowed and covered with water for 2 to 3 weeks without injury. On drier soils very good pastures are also made. On rich lowlands redtop sometimes grows 4 feet high and yields 3 tons of hay per acre.

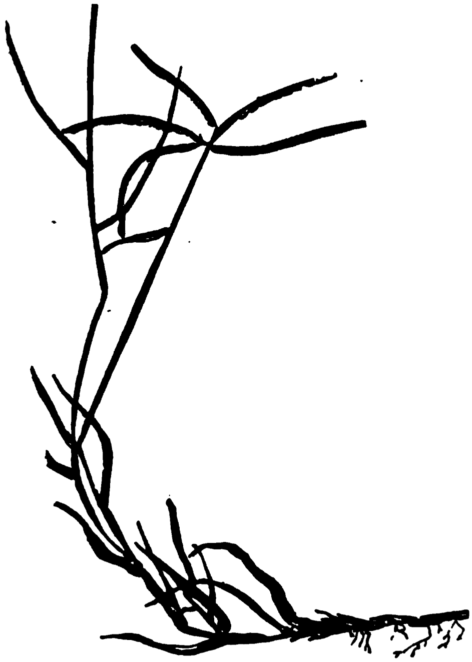

Fig. 40—BERMUDA GRASS

These grasses are cultivated chiefly in the Eastern and Middle States as far South as Tennessee. Experiments at the experiment stations show that they are well adapted to nearly all parts of the United States, growing a little taller in the South than in the North.

As a hay crop the bent grasses are not very satisfactory. The yield is light, varying from ½ to 2 tons of cured hay per acre. The crop should be cut just before the seed matures. They are easily seeded either alone or with other grasses, particularly timothy, and maintain themselves well against weeds. Seeded alone 1 to 2 bushels per acre are required. The method of seeding is that observed with timothy. They require 2 or more years to become thoroughly established, and are therefore not satisfactory in rapid rotations. Rhode Island bent and creeping bent (Fig. 39) are both excellent lawn grasses. For this purpose the former should be seeded at the rate of 3 to 4 bushels per acre and the latter 3 bushels. For composition see *Appendix.*

Bermuda Grass (*Cynodon dactylon*)—A low perennial grass having a creeping habit of growth. It roots at the joints and forms a close sod. The leaves at the base of the plant are short and numerous and the upright flower stem on poor soils only a few inches high. (See Fig. 40.) On richer soils the nearly leafless stems may grow 1 to 2 feet high. It is a native of the tropics and produces seed in quantity only in the extreme southern portions of the United States. Bermuda is one of the most valuable pasture grasses of the South and is propagated to some extent on the Pacific coast. It is very resistant to heat and drouth, but will not thrive in the shade, and is very susceptible to hard frosts. It is not profitably grown north of Virginia and Kentucky.

As a hay plant it may be cut 3 or 4 times each season, and under ordinary conditions will yield 1 to 2 tons of nutritious hay per acre. It is pre-eminent, however, as a summer pasture crop, flourishing where other grasses are parched and dead and withstanding grazing and the trampling of stock better than any other grass. Bermuda grass will grow on nearly all soils unless too moist. It prefers rich, sandy and alluvial soils. It is propagated either by seed or by sowing or planting the chopped sections of the rootstocks. Seed is rarely used, since it costs $1 to $1.25 per pound. The roots for sowing are prepared by shaking the dirt from them and running them through a cutting box. These cuttings, about an inch long, are sown broadcast and lightly harrowed in. Sown with oats, the grass is ready to occupy the field as soon as the oats are harvested. Pieces of Bermuda grass turf may be used in the same manner. The grass spreads very rapidly and soon completely occupies the whole field. It should be cut early and often for good hay.

Bermuda grass once established is very persistent and is a troublesome weed in tillage, and should be used mostly for permanent pastures. It can be eradicated by shallow fall plowing so as to expose the roots to frost, followed by cotton with clean cultivation and cowpeas for 2 or 3 seasons. The grass is especially valuable in lawns not too far north, as it remains green when all the other grasses are parched and yellow. It turns brown, however, with the first heavy frosts. It is particularly valuable for binding drifting sands and to keep the soil from washing. (See also Okla. Expt. Sta. Bul. 55; U. S. Dept. Agr. Div. Agrostol. Circ. 30.)

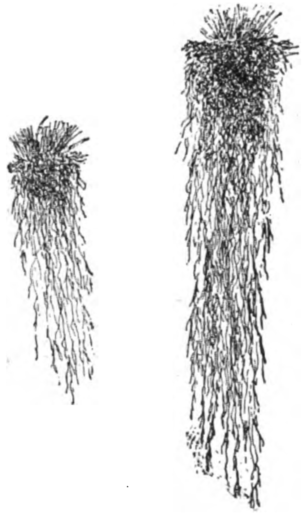

Fig. 41—COMPARATIVE GROWTH OF BROME GRASS AND TIMOTHY ROOTS

Big Blue Stem (*Andropogon provincialis*)—A stout perennial 2 to 6 feet high, with numerous long, rough-margined leaves and flowers in 2 to 5 short spikes at the apex of the stem or its branches. It has a wide range east of the Rocky Mountains along river bottoms and such places and is particularly abundant along the Mississippi River. It is well liked by stock both as green forage and as hay. The Iowa Station states that it is an important factor in the hay production in the western portion of the State and brings a higher price in the market than any other wild hay, and that for horses many farmers prefer it to timothy. It starts late in the spring and the early growth consists of an abundance of long, succulent leaves. The plant should be cut in early bloom for hay. If not cut until fully matured the stems become hard and woody and the hay is of inferior quality. It is said to mature seed rarely. Blue Stem thrives on poor, sandy and rocky soils as well as on the richer prairies.

Little Blue Stem (*A. scoparius*) grows in bunches and is common on the prairies, especially on the poorer, sandy soils. It is valuable for hay, but is not so productive as the big blue stem. It is useful as a fall pasture plant.

Blue Joint (*Calamagrostis Canadensis*)—A native perennial grass common in low, moist meadows or wet, boggy grounds in the Northern and Northwestern States west to the Pacific. The smooth, hollow stems are 3 to 5 feet high and bear open brown or purplish panicles much resembling redtop. The leaves are rough, about a foot long and half an inch wide. The plant spreads by underground shoots and is sometimes found occupying considerable areas to the exclusion of other grasses. It seeds sparingly. The hay made from it is highly prized by farmers, being nearly as good as timothy and readily eaten by all farm stock. It grows naturally in low, moist meadows, but has succeeded well under cultivation. It should be cut early for the best hay. Its more extended culture for hay in the northern portion of the United States is recommended by the United States Department of Agriculture. For composition see *Appendix*.

Brome Grass (*Bromus inermis*)—Smooth, Awnless, Hungarian or Australian Brome Grass, as it is variously called, was introduced into this country from Europe about 20 years ago. It is a vigorous, hardy perennial, with strong creeping rootstocks and smooth, upright leafy stems 1 to 4 feet high, having loose open panicles 4 to 8 inches long. It is valuable for both pasturage and hay. Extended cultural tests throughout the country show that it has remarkable drouth-resisting qualities and is the most suitable grass yet introduced for the dry regions of the West and Northwest. Once established, it withstands a temperature many degrees below zero without injury. It will thrive on extremely poor, sandy lands and return a fair crop. On better soils it grows rapidly, producing an abundance of pasture and yielding from 1 to 4 tons of cured hay per acre. All stock relish it, and at the North Dakota Station it gave better results in feeding experiments with horses than good timothy hay. As a pasture grass for milch cows it gave excellent results at the Nebraska Station.

That station says of it that "all things considered, *Bromus inermis* is the most promising cultivated pasture grass for this State that has been tested on the station farm. After once having become established it is unaffected by cold. During periods of extreme drouth is lessens growth, but does not die. Its advantages over the native grasses are that it becomes green fully a month earlier in the spring and does not dry up in summer. It also remains green late in the fall. Indications are that it will carry more stock to the acre than most of the prairie pastures. It does not make a good mixture with other grasses. but does well with red clover. As a pasture for dairy cattle it is not equal to a mixture of blue grass and white clover, nor by any means equal to alfalfa as a milk and butter producer, but it is absolutely safe. Tests throughout the State indicate that it is adapted to a greater range of territory than any other cultivated grass." In South Dakota it has proved the best pasture grass tested.

In a comparison of brome grass with timothy at the North Dakota Station the brome grass far outyielded the timothy. one year producing ¾ to 1½ tons per acre when timothy was a total failure from drouth. Analysis showed that brome grass hay contained about twice as much protein as the average analyses of timothy for the whole country, and about the same amount of fiber. (See *Appendix.*) An examination of the roots showed that while those of timothy extended downward but 3½ feet, the brome grass roots went down 5 to 6 feet, and were much greater in bulk. (See Fig. 41.) The brome grass was found to be a better humus former than timothy and left the soil in better chemical and physical condition.

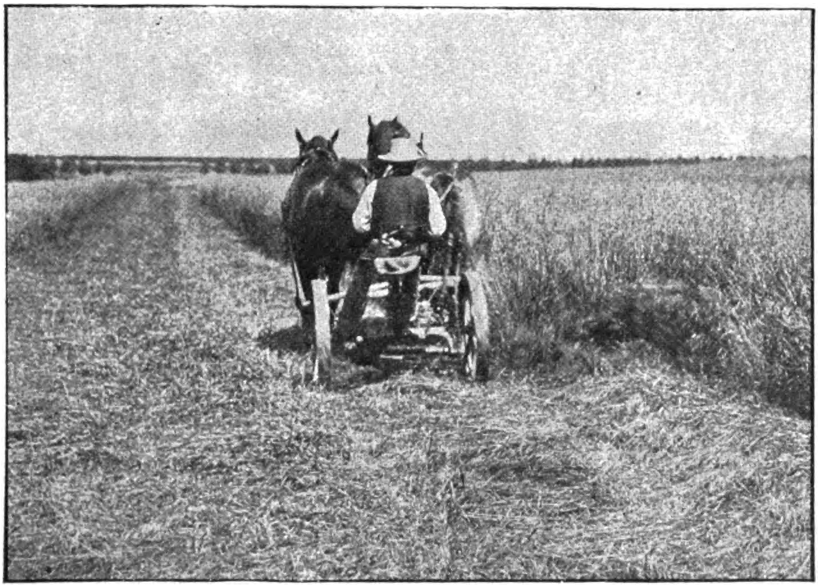

Fig. 42—MOWING BROME GRASS

Brome grass is best seeded broadcast at the rate of 18 to 20 pounds per acre without a nurse crop. The land should be well prepared by plowing and harrowing and the seed sown in the spring or even as late as August 1. In some parts of Oregon, California and Washington fall seeding in October or November has been found best. It should be cut for hay when in full bloom and handled like timothy, as seen in Fig. 42.

There is one caution to be observed. Since the plant propagates itself by creeping rootstocks, it is liable to become a weed, and is best used in permanent pastures. However, it can be readily eradicated by giving attention to good culture.

(See also U. S. Dept. Agr. Div. Agrostol. Circ. 18; N. D. Expt. Sta. Bul. 47; Neb. Expt. Sta. Bul. 61; Colo. Expt. Sta. Bul. 61.)

Buffalo Grass (*Buchloe dactyloides*)—One of the most valuable wild grasses of the great plains. It is a low plant, the bulk of the leaves seldom rising more than 3 or 4 inches above the ground. It grows in extensive tufts or patches and spreads largely by means of runners. These are sometimes 2 feet long, with joints every 3 or 4 inches, which form roots and send up flower stems. The flowers are mostly dioecious, but sometimes both male and female flowers are found on the same plant. The grass is very nutritious. It is reported to seed well or to grow from cuttings of the runners. The low growth of this grass makes it valuable only for pasture or lawns and more particularly in those regions where it grows naturally. A plant and runner are shown in Fig. 43.

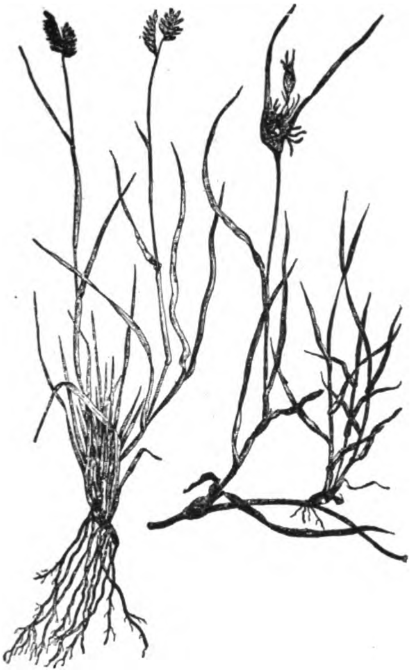
Fig. 43—BUFFALO GRASS

Carpet Grass (*Paspalum compressum*)—A Southern grass native along the coast and common in Mississippi and Alabama. It is also especially abundant on the prairies of Louisiana and is sometimes called Louisiana grass. It is a low, creeping perennial, too short for hay, but considered one of the very best pasture grasses for sandy soils in the South. The plant roots at the nodes and sends up numerous flower-bearing branches 6 to 24 inches high, which bear 2 to 3 slender spikes at their summits. On the heavier soils Bermuda grass may crowd it out, but on moderately fertile, light soils it quickly covers the ground, forming a thick carpet of grass to the exclusion of all other weeds and grasses. It withstands the tramping of stock the best of all Southern grasses, withstands drouth well, is unaffected by frosts, and in the more Southern districts remains green all winter. On the lighter soils where Bermuda grass will not do well it makes an excellent lawn grass and is often used for this purpose. Seed is seldom found in the market. The plant is usually propagated by cutting the hay when the seed is ripe and scattering it over the freshly cultivated field. Where a few plants grow the grass is soon scattered over the whole field by stock and otherwise. The grass is easily destroyed by cultivation and is not dangerous as a weed.

Crab Grass (*Panicum sanguinale*)—This annual grass is common in nearly all parts of the United States and is a weed in many gardens and fields. In the Southern States it is especially abundant, and when cultivation ceases or after harvesting a grain crop, it frequently springs up in such quantity as to afford 1 or 2 good cuttings of hay. It grows from 2 to 4 feet high, the stems are much branched and bear 3 to 12 slender purplish flower spikes. The stems are usually bent at the base and roots are frequently thrown out at the lower joints. The grass prefers a rather moist soil. It is never sown, but comes up spontaneously when cultivation of other crops ceases, forming excellent pasture in the South from June to October, or until heavy frosts come. It makes a hay much relished by stock, and for this purpose it should be cut before the seed ripens. The hay is easily cured in dry weather and is of good quality; but is easily leached of its nutritive qualities by rain. It does not shed rain well, and if stacked in the open field should be capped with some other grass. Two or more cuttings per season are usual. In Bohemia and some parts of Germany crab grass is cultivated on sandy soils for the seed, which is cooked and eaten as a mush or porridge. For composition see *Appendix.*

Cord Grass (*Spartina cynosuroides*) —This is a coarse perennial native grass found along the shores of the ocean, lakes and rivers throughout the northern half of the United States. It grows 2 to 6 feet high, with many flat, long pointed leaves and numerous erect or spreading spikes, 2 to 5 inches long. Cut early it makes a fair but rather coarse hay. It has creeping rootstocks and is considered valuable as a sand binder and for thatching.

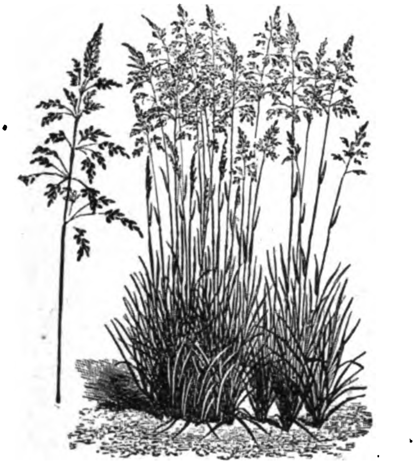

Fig. 44—FOWL MEADOW GRASS

Fowl Meadow Grass (*Poa flava*)—A native grass found in wet meadows and low bottom lands in Northeastern United States. It grows 2 to 3 feet high. The leaves are narrow, 3 to 6 inches long; panicle rather dense and 6 to 14 inches long. The name, fowl meadow grass, is derived from the supposed introduction of this grass by water fowls in the low meadows at Dedham, Massachusetts. False Redtop is another name given to it, due to its great resemblance to that grass and the fact that they are usually found growing together. It may be distinguished from redtop, and also from the closely related blue or June grass, by the absence of running rootstocks. (See Fig. 44.)

Fowl meadow grass makes a hay of good quality. The stem remains green and succulent after flowering, so that the crop need not be cut for hay until the seed is mature. This permits of the gathering of a crop of seed and of straw at the same harvesting. The second growth starts slowly like timothy and is not, therefore, well adapted to pasture. Fowl meadow grass will grow on nearly all well cultivated land, but prefers a moist situation. Seeded alone it makes a poor sod. Its slender stem and heavy tops incline it to lodge. Some other stronger growing grass, like redtop, should, therefore, be grown with it.

Gama Grass (*Tripsacum dactyloides*)—This is a coarse native perennial grass 3 to 8 feet high, with many broad leaves resembling in size and appearance those of corn, and large creeping rootstocks. It is very succulent when cut green and is eaten greedily by stock. The Tennessee Station considers it valuable for soiling, forage, or the silo, and states that while it naturally grows in swampy places, it will thrive almost equally well on dry or sandy ridges. It is native from Connecticut to Kansas and South to Florida and Texas. The seed vegetates with difficulty and the plant is therefore best propagated by root cuttings. In planting, rows should be made about 2 feet apart and the cuttings placed 1 foot apart in the rows. The grass may be cut 2 or 3 times a year and produces an enormous amount of forage. It should always be cut before the seed

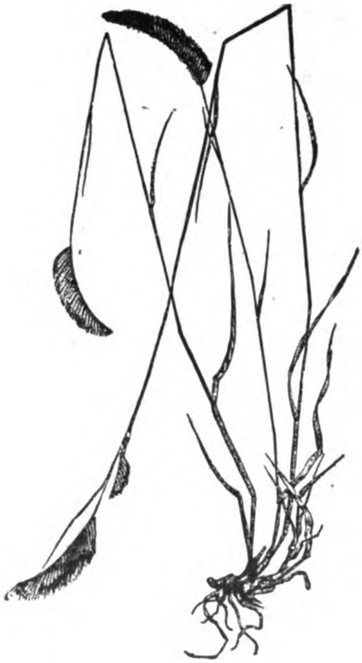

Fig. 45—GRAMA GRASS

stalk is sent up if desired for hay. It is an attractive plant for lawn decorations.

Grama Grass, Mesquite Grass (*Bouteloua* spp.)—The blue or white grama (*B. oligostachya*) is one of the most abundant and valuable of these grasses. It is a perennial 6 to 18 inches high, with numerous narrow root leaves. It is native to the plains from Wisconsin west and south to California and Texas. It resists drouth and the tramping of stock well and is unsurpassed for grazing wherever it grows in these regions. It cures into good hay while standing, like buffalo grass, and is used for this purpose where found in sufficient quantity. Black grama (*B. eriopoda*) is especially abundant in Texas and New Mexico and forms one of the most valuable grazing grasses of that region. It grows 1 to 2 feet high, often forming a dense turf, and is distinguished by having woody, jointed stems. (Fig. 45.)

Tall grama or Side-oats (*B. curtipendula*) has a wider range of territory, being native from New Jersey west to the Rocky Mountains and south to Mexico, and is one of the tallest gramas, ranging from 1 to 3 feet. It is a perennial, with tough, fibrous roots, long, narrow leaves, with the numerous spikes arranged one-sided along the upper portion of the stem. It grows in bunches. It cures readily, making a hay of excellent quality. Under cultivation at the Iowa Station it made a good stand, in one season producing a fine, even turf 6 inches to 2 feet high, and in the autumn had developed sufficiently to produce 1 to 1½ tons of hay per acre. It is considered well worthy of cultivation on dry soils.

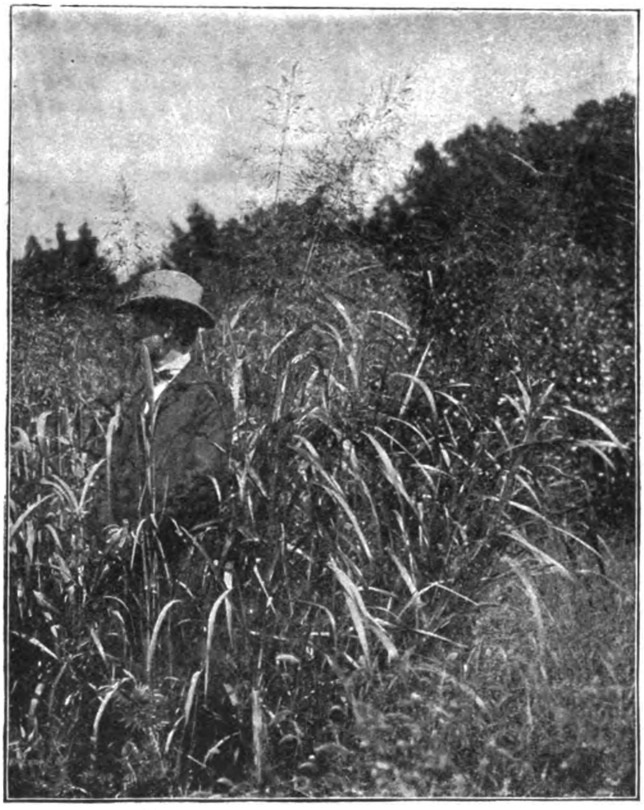

Fig. 46—FIELD OF JOHNSON GRASS
(U. S. Dept. Agr.)

Johnson Grass (*Andropogon halepensis*)—This grass was introduced into this country from the old world about 1830, and is now well distributed throughout the Southern States. It is a rank growing perennial 3 to 6 feet high, with numerous long leaves, panicles 6 to 12 inches long, and strong creeping rootstocks. It thrives best in calcareous and especially rich alluvial soils, but will grow on the poorest soils, withstanding all drouth. It is especially valuable for hay, giving 2 to 3 cuttings a season, with a total yield of 3 to 5 tons per acre. The hay is coarse in appearance, but rivals timothy in quality and is greedily eaten by stock. For composition see *Appendix.*

Johnson grass possesses no merit for pasture. Since it starts growth late in the season, the tops are killed by the first fall frosts and the fleshy rootstocks are so near the surface of the ground that the trampling of stock seriously injures them, causing the plant to practically disappear from the field. These rootstocks are greatly relished by hogs and are considered by the Tennessee Station equal to artichokes for hog feeding.

For hay the crop should be cut before the heads appear. When grown from seed it requires about 1 bushel of seed per acre, or root cuttings may be set a foot apart either way. After the plant has been cut for hay for 3 or 4 years the roots become so matted that the yield is decreased. The field should then be plowed up either in winter or early spring and thoroughly harrowed, after which the grass will grow in all its original luxuriance, as seen in Fig. 46.

Johnson grass is the most prolific perennial grass grown in the South, and at the same time it is one of the most serious weed pests. Once established it is almost impossible to eradicate it. Persistent and continuous cultivation from early spring to late fall may kill it on poor, sandy lands if it is continued for a season, but it is likely to survive this treatment on the better soils. Ball recommends the summer plowing of fallow land during the 2 hottest and driest months of summer as the best means of killing it. The first plowing should be about 2 inches deep. The second plowing should be about 2 inches deeper and crosswise of the field. Johnson grass may practically disappear from a field when pastured for a number of years, but the roots remain alive and the plant will immediately reappear in luxuriance when the field is again brought under cultivation. Salt has been recommended to destroy it, but has little value, even when the plants are covered half an inch deep. The plant is so difficult to eradicate that it should never be sown in the South on clean land that is ever intended for any other purpose. "If it is already established on the land it is often better to encourage it than to fight it, as a heavy crop of good hay is more profitable than an ordinary crop of either corn or cotton."*

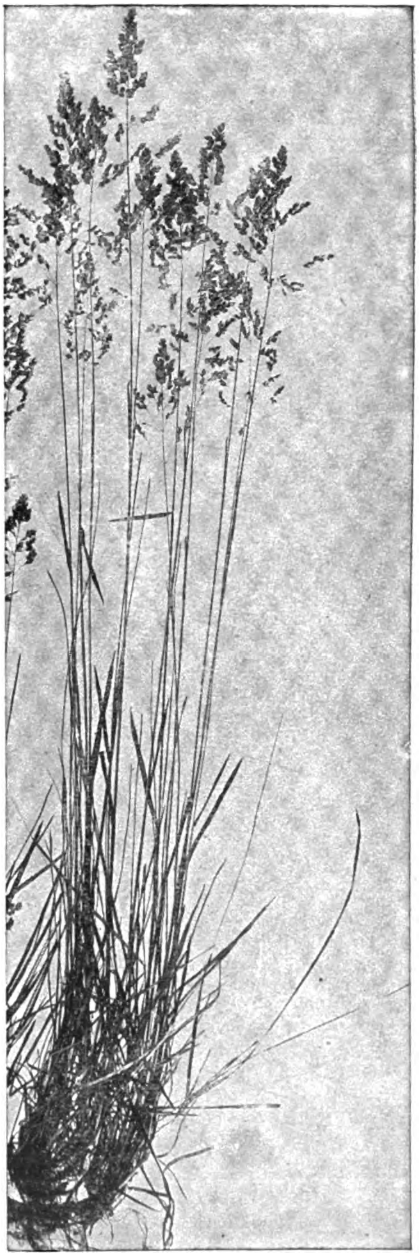

Fig. 47—KENTUCKY BLUE GRASS
(U.S. Dept. Agr.)

The plant has been grown in Nebraska as an annual from Southern seed with some success. (See also U. S. Dept. Agr. Bureau Plant Industry Bul. 11; Kan. Expt. Sta. Press Bul. 78.)

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*Prof. Spillman has recently reported that alfalfa makes an excellent crop to grow on Johnson grass infested land. The 4 or 5 cuttings necessary for alfalfa are sufficient to completely control the Johnson grass.

Kentucky Blue Grass (*Poa pratensis*)—This grass is also known as June grass, spear grass, meadow grass, pasture grass, etc. It is native from South Carolina west to the Pacific and north to Alaska and Labrador, but attains its greatest perfection in the limestone regions of Kentucky and Tennessee. There it is the king of pasture grasses, and these regions have become world famed as stock centers. In the Middle and Eastern States it is a prominent constituent of all permanent pastures, but it is not so satisfactory for hay as some other grasses because of its lighter yield. In the far South it has not proved very satisfactory. The plant is a perennial, growing 6 inches to 2 feet high, with many long, narrow root leaves. (See Fig. 47.) It spreads rapidly by means of seed and various runners or suckers, forming a close, compact sod that withstands trampling and grazing well. It bears drouth well, and though it may appear brown and sere after a hot, dry summer, it rapidly recovers with the first autumn rains, furnishing an abundant supply of rich, green pasture. Kentucky Blue Grass does best on calcareous loams of a clayey rather than a sandy nature. It may be seeded any time of year, but preferably in the fall in September or October, or any time in winter when the snow is on. Seeded in the fall, it should be lightly brushed in. The seedbed should be firm and compact. From ½ to 2½ bushels of seed per acre are required. This large amount is due to the low vitality of the seed offered for sale on the market. Most of it has a vitality below 20 per cent, and much of it below 10 per cent.* The plant is slow to take possession of the ground, and from 2 to 3 years are required before it becomes firmly established. Once established, however, on suitable soils it endures for many years, and should form a prominent part in all grass mixtures for permanent meadows. It is a favorite lawn grass and makes a firm sod that is well suited for turfing. For lawns not less than 3 bushels per acre should be sown. For composition see *Appendix*.

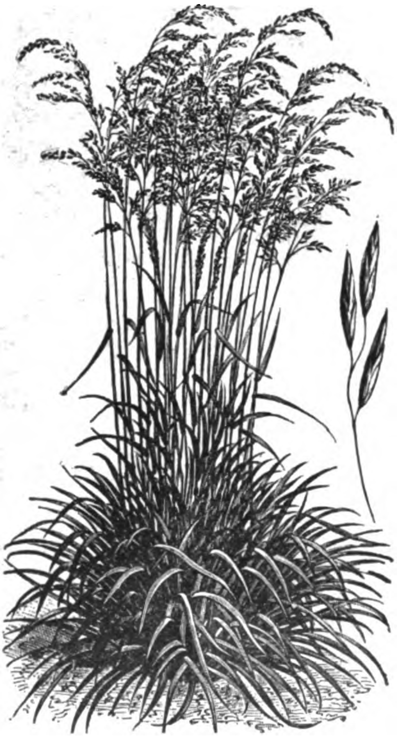

Fig. 48—TALL MEADOW FESCUE

Meadow Fescue (*Festuca elatior*)—This grass was introduced from Europe and has become naturalized all over the United States. It is exceedingly valuable both as a pasture grass and hay and especially desirable in permanent pastures, as it is of long duration. South of Virginia and Kentucky it remains green over winter. It thrives best on rich, moist clay or marl soils, but will do fairly well on drier soils; though the Iowa Station notes that in that State it is less able to resist drouth than timothy, blue grass or orchard grass.

Its cultivation in this country is confined chiefly to the Eastern States. Meadow fescue is a perennial, 2 to 5 feet high, and usually tufted or growing in bunches like orchard grass. (See Fig. 48.) The roots are stout and fibrous, leaves 1 to 2 feet long and rather abundant. It is propagated from seed, sown at the rate of 2 to 3 bushels per acre in the same manner as timothy or blue grass. The grass does not become fully established until about the third year. On good soils it will yield from 1 to 1½ tons of hay the first year and double this the second. It should be cut for hay when in flower. Overflows do not injure the plant, but are said to increase its vigor.

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*This low vitality has been found by Pieters and Brown to be due to faulty methods of harvesting and consequent fermentation and deterioration of the seed. (See U. S. Dept. Agr. Bureau Plant Industry Bul. 19 on methods of harvesting, curing and cleaning blue grass seed.)

This grass should form a part of every mixture for permanent pastures. In Virginia it is known as Randall grass; in North Carolina, evergreen grass, and sometimes it is called tall fescue.

Meadow Foxtail (*Alopecurus pratensis*)—A hardy perennial grass much resembling timothy in appearance, but with shorter leaves and stalk, shorter, thicker and softer spike, and starts into growth from 3 to 4 weeks earlier in the spring than timothy. (See Fig. 49.) It is cultivated to some extent in the Middle and New England States, being particularly valuable as a permanent meadow and pasture grass in moist situations, where it lasts well. It is seldom grown alone, as it is 2 to 3 years in getting fully established, but should form a part of all permanent meadow grass mixtures. It makes a lighter hay than timothy, but one fully equal to it in nutritiveness. On rich soils it will yield 1 to 2 tons of hay per acre. It will stand high manuring and does not spread like June grass. Its chief value, however, is in mixtures for permanent pastures and meadows. The Iowa Station notes that it is of but little value in that State.

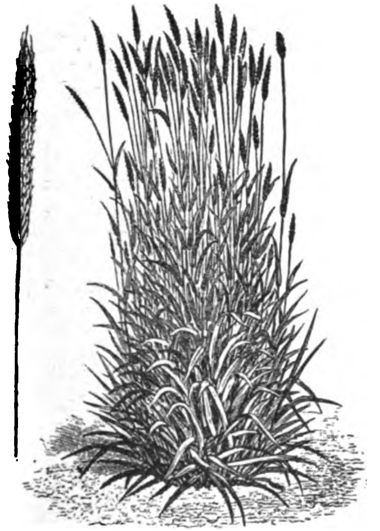

Fig. 49—MEADOW FOXTAIL

Orchard Grass (*Dactylis glomerata*)—A popular, vigorous-growing, hardy perennial grass, well suited for hay and pasture everywhere in the United States except the extreme South and the arid portions of the West. It grows 2 to 4 feet high, bearing several leaves on its stem and numerous root leaves and yields from 1 to 3 tons of hay per acre. The aftermath is abundant, and with 5 or 6 days' growth furnishes a good bite for all stock. It endures shade well and is therefore suited for culture in the open woods and orchards. Orchard grass thrives in all moderately rich soils not too retentive of moisture. It responds promptly to top-dressings of barnyard manure. For hay it should be cut when in bloom or just before, as otherwise it becomes woody. In favorable seasons 2 to 3 cuttings can be obtained.

The seed may be sown either in the fall or early spring. When sown alone 2 to 3 bushels are required per acre. It should be seeded broadcast and lightly harrowed in. A good pasture is obtained the first season. It is in mixtures, however, that orchard grass is most useful. It is especially adapted for seeding with clover. When seeded alone the grass has the fault of growing in bunches or tufts. This can be remedied in a measure by thicker seeding, combining in mixtures and rolling. In old meadows spring harrowing and rolling are recommended. Experiments at the Rhode Island Station indicate that orchard grass is greatly benefited by liming.

When seed is desired instead of hay the crop should be cut with a reaper and the bundles set up in shocks like wheat, except that no sheaf caps need be put on. It should be threshed directly from the shock rather than stacked, to avoid as much as possible shattering of seed.

Orchard grass is especially desirable in permanent pastures, as it starts into growth very early, endures drouth and the trampling of stock well, grows rapidly and produces an abundance of herbage greatly relished by all farm animals. For composition see *Appendix*.

Reed Canary Grass (*Phalaris arundinacea*)—This is a tall, leafy perennial grass native to low meadows and marshy lands throughout the Northern States and Canada. It grows from 2 to 4 feet high. The leaves are 6 to 10 inches long and about ½ inch wide. Panicles branching and 4 to 8 inches long. It is little affected by either drouth or cold and will do well in the shade. It makes a fair coarse hay. The Iowa Station states that it succeeds admirably under cultivation even in dry soils, and at the station resisted drouth as well as any grass under cultivation. It prefers stiff, wet lands and flooded situations. It is propagated either by seed or by rootstock cuttings. The cuttings should be placed about a foot apart and lightly covered. Two years are required before the cuttings come to full maturity. For hay the grass should be cut before flowering, otherwise it becomes woody and hard.

Rescue Grass (*Bromus unioloides*)—This grass is also known as Schrader's brome, Australian brome, Australian oats, Arctic grass, etc. It grows 1 to 3 feet high and much resembles chess in appearance, to which weed it is closely related. It is naturally an annual, but if prevented from bearing seed by close grazing or frequent cutting it will live several years and produce well. In the South, where it is grown to a considerable extent as a winter grazing grass, it is the common custom to seed it in August or September at the rate of 30 to 40 pounds of seed per acre. By January or February it will furnish an abundance of pasture until spring, when it should be allowed to ripen seed and thus reseed itself, after which a crop of cowpeas, crab grass or Japan clover may be grown. When these crops are removed in the fall the rescue grass will again come on and furnish winter pasture. The essential factor in this method of growing the grass is to permit it to reseed itself each spring. If this is not done the grass dries up during the summer, the use of the ground is lost and the plant soon runs out. In the cooler regions the grass should be sown in the spring. It will then remain green until late fall. It does well on almost any soil, but prefers a rich loam. Under favorable conditions it will give 2 cuttings per season, yielding 1 to 1½ tons per acre of hay of good quality.

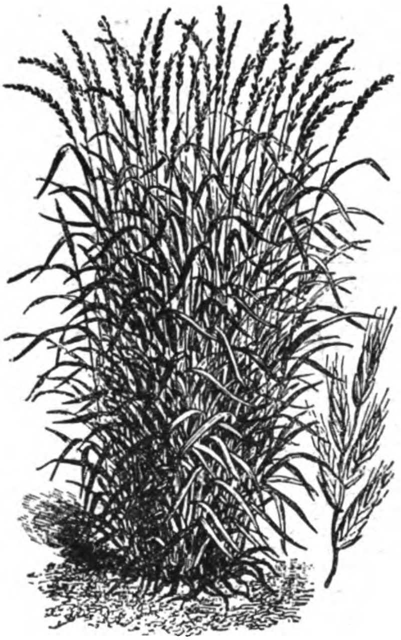

Fig. 50—ITALIAN RYE GRASS

Rye Grasses—The more common of these grasses are the Italian rye (*Lolium Italicum*) and Perennial rye (*L. perenne*). These are European grasses, and, while very popular, they have not proved especially desirable here except in a few localities. The Italian rye grass is a biennial, and therefore not suited for permanent pastures. It flourishes best in the Eastern States and particularly in the region from southern Pennsylvania to Virginia, requiring for its best growth moist, loamy lands of a calcareous nature. On such soils it is an excellent hay grass and grows very rapidly when regularly fertilized with either barnyard or liquid manure. Cuttings may be obtained 4 to 6 weeks after seeding and at similar intervals thereafter throughout the season. This rapidity of growth taken in connection with the succulent character of the grass, makes it especially valuable for soiling purposes. The grass does not withstand drouth, nor does it do well on stiff clays. The plant grows in broad, compact tufts about 2 feet high or more and produces a number of stems from a single root, which bear an abundance of long leaves. It is distinguished from Perennial rye grass by having awned or bearded spikelets, as seen in Fig. 50.

For hay rye grasses should be cut when in full bloom. The yield is 2 to 3 tons per acre. Seeded alone 2 to 3 bushels are required per acre. In mixtures about 1 bushel per acre should be used. Seedings may be made either in the fall or the spring. The rapid growth of these grasses soon covers the ground with a dense mat of long leaves, which, if not closely grazed or mowed, will soon rot and cause the roots to decay. The Italian rye grass will not last over 2 or 3 years at best, and is, therefore, not valuable in permanent meadows. It is most useful in mixtures like redtop or orchard grass, which increase in value as the rye grass decreases.

The Perennial rye differs little from the Italian except as noted above and in being longer lived. It requires similar soil and cultural methods. It will never replace timothy where timothy does well. For composition see *Appendix*.

Sheep's Fescue (*Festuca ovina*)—This fescue differs from meadow fescue only in its much smaller size. On thin soils the hight rarely exceeds 8 inches, though some varieties attain 2 to 3 feet. It is native to the Northwestern States, and in some localities produces an abundance of herbage that is greatly relished by sheep and to a less extent by other stock. Sheep's fescue and all its varieties are perennial "bunch grasses," and are devoid of creeping rootstocks. It is especially suited for culture on the lighter, drier soils of a sandy nature where other grasses will not thrive. Two and one-half to 3 bushels of seed are required per acre. The grass yields too little to cut for hay and is valuable for pasture only in the drier regions of the West and on soils too poor to grow better grasses. The grass is also native in Europe and is said to be especially abundant in the sheep grazing districts of Scotland.

Texas Blue Grass (*Poa arachnifera*)—This is a native Texas grass now well distributed throughout the Southern States. It is a perennial pasture grass closely related to Kentucky blue grass, but more vigorous than that plant, growing faster and to a greater hight. It has a few long leaves on the stalk, creeping rootstocks with many long root leaves, and narrow, densely flowered panicles. The seed are very woolly, adhering closely, and difficult to sow. The plant forms a thick turf well suited to permanent pastures. It is especially valuable for fall and winter grazing, since it makes its principal growth during the winter months, coming into bloom in April and May. Even as far north as Tennessee it remains green throughout the winter. It withstands drouth better than Kentucky blue grass, but will not endure the severe freezes of the Northern States.

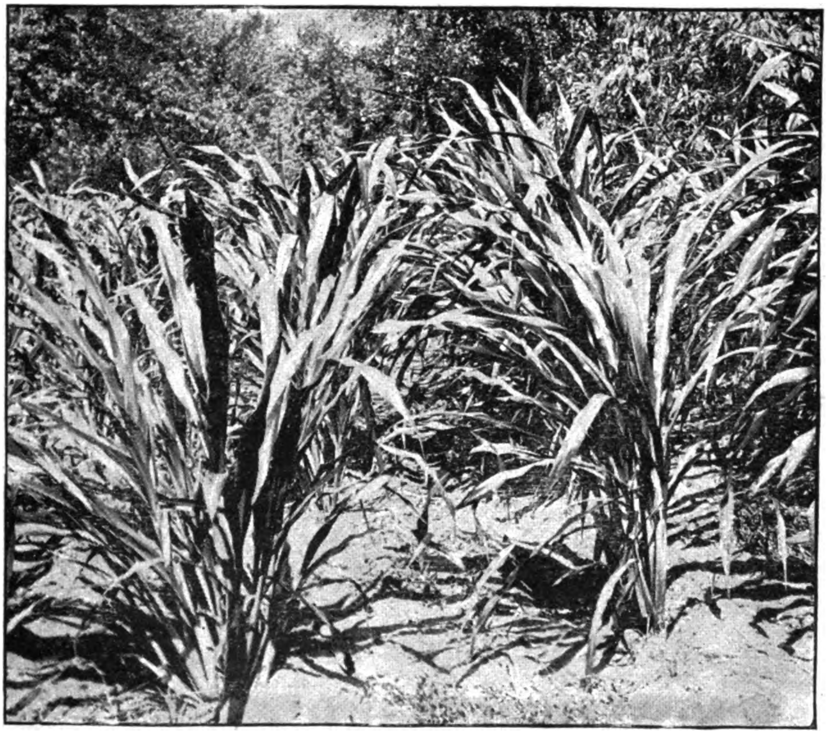

Fig. 51—SECTION OF FIELD OF TEOSINTE
(Tenn. Expt. Sta.)

Because of the high price of the seed and the difficulty of sowing the same, the plant is usually propagated from roots. The chopped sections of the rootstocks should be planted 6 to 10 inches apart in rows 2 feet apart. The creeping rootstocks soon fill the intervening space, crowding out all weeds and wholly occupying the ground, making a firm sod, within a year or two, that will withstand all tramping. September or October is the best time for planting. When the seed is planted it should be in drills a foot apart and lightly covered. Any good soil, especially calcareous loams, not too moist, will grow this grass to perfection. Its growth after fall rains is said to amount often to an inch per day.

Tall Oat Grass (*Arrhenatherum elatius*)—An European perennial 2 to 4 feet high, which has found favor in the North and as far south as Tennessee and Northern Georgia. It produces an abundance of leaves and tall stems, is hardy and resists drouth well, but seems unsuited either for hay or green forage except in mixtures. It grows best on well drained, rich, upland loams and should be seeded like timothy, the ground being first well prepared. The blossoms appear early. The crop should be cut for hay as soon as the first of these appear. The second season it yields better than the first. Two to 3 cuttings are obtained annually and the yield varies from 2 to 4 tons per acre. This grass should be sown only in mixtures and then should never exceed 20 per cent of the total seed sown. The hay is inferior to either timothy or orchard grass.

Teosinte (*Euchloena luxurians*)—A rank growing annual grass 8 to 12 feet high. It resembles Indian corn in appearance and botanically is closely related to it. The two readily cross with each other, forming fertile hybrids. It is a native of the warmer parts of Mexico and Central America and has been cultivated in various parts of the South and West, but rarely produces seed north of Southern Florida and Louisiana. Under favorable conditions it is one of the heaviest forage plants ever grown in this country. At the Georgia Station it yielded at the rate of 38,000 pounds of green forage per acre, at the Mississippi Station 44,000 pounds and at the Louisiana Station over 50 tons of green forage. In New Jersey it did not yield as well as corn. At the Michigan Station it grew but 4 or 5 feet high. It gave heavy yields of good fodder at the Arizona Station, but required too much water to be desirable for that State. It is most successfully grown on rich soils where the seasons are long and there is an abundance of hot, moist weather. Elsewhere it possesses no advantage over corn. The plant tillers abundantly, sending up from 20 to 50 stalks from a single root. If harvested when 4 or 5 feet high, 2 or 3 cuttings may be obtained in a single season. A better quality of forage and nearly as great a yield can be obtained by allowing the crop to grow and cutting but once, about the middle or last of September, before frost comes. A crop of teosinte grown in Tennessee is seen in Fig. 51.

The plant contains from 8 to 10 per cent of sugar. The leaves are long and abundant and the stalks tender, so that there is no waste to the crop whatever. The forage is of the best quality, and the whole plant is greedily eaten by all stock. It makes an excellent crop for the silo or for soiling, and is especially valuable for feeding green in the summer when other forage crops are dried up. At the Oklahoma Station teosinte lost about 1-3 of its feeding value by exposure in the field over winter. This loss can be largely prevented by stacking so that only the butts of the stalks are exposed.

The crop should be planted in May or June on good corn soil in rows 3½ to 4 feet apart and thinned to 1 plant every foot. One pound of good seed will be sufficient to sow an acre. As noted above, this crop is of especial value only in the South, and in Northern localities it is in no wise equal to corn as a forage crop. For composition see *Appendix.*

Terrell or Wild Rye Grass (*Elymus Virginicus*)—A native perennial grass very common in marshes and along streams and the borders of woods and thickets. It is erect, with smooth stems 2 to 3 feet high. It grows rapidly and is promising as a winter and spring pasture in the South and for woodland pastures in some of the Western States. It does not withstand close pasturing during the summer, and at present there are many other grasses much superior to it for agricultural purposes.

Timothy (*Phleum pratense*)—This is the most widely grown and popular hay grass cultivated in the United States. It is the standard hay of commerce and the one by which all others are compared. It is a perennial grass 1½ to 4 feet high. It grows best in the rich, moist loams of lowlands and gives decreased yields on lighter soils and dry uplands. Clay loams are more satisfactory than sandy loams. It grows in stools and never forms a close, compact sod. The roots are very fibrous, but feed shallow. The crop, therefore, will not withstand drouth as well as some other grasses, and for the same reason is very responsive to top-dressings of barnyard manure and other fertilizers, more particularly nitrate of soda and sulphate of ammonia. At the Ohio Station phosphoric acid proved very beneficial, and on acid soil at the Rhode Island Station lime increased the yields. A luxuriant timothy field is seen in Fig. 52.

Timothy will not stand heavy pasturing. Except under the most favorable conditions, it will not endure at most over 5 or 6 years, when it will run out. It is, therefore, seldom used alone for pasture, but mixed with redtop, orchard grass or red clover. In the more moist situations alsike clover may replace the red clover. In such mixtures the timothy may endure 12 or 15 years. It is, however, pre-eminently a hay crop.

Timothy is seeded both with and without a nurse crop. Very good results are obtained by both methods. In dry years it is best to seed without a nurse crop. In the Eastern and Northern States it is usually seeded in the fall with wheat and in the spring with oats, and this is sound business policy. Fall seeding about September usually gives the best results in these States. In the Northwest, more particularly in the prairie regions, where the falls are liable to be dry until late, early spring seeding when the ground is more moist gives the best results. Preparation of the soil as for wheat will give satisfactory results with timothy. A compact seedbed and rolling on the lighter soils is desirable. A full crop is not secured until the second year.

Seeded alone timothy should be put in either broadcast or with a seeder at the rate of 12 to 15 pounds per acre. In general farming in the North timothy and clover are usually mixed for seeding Ten pounds of timothy and 4 pounds of clover seed make a good seeding per acre. At the first cutting the clover is likely to predominate in the hay, but at the second and subsequent cuttings the timothy will be in excess. About the third year the clover will disappear entirely. If the hay is to be sold the price will increase in proportion to the timothy it contains. Nevertheless, for home use the addition of clover is very desirable, not only on account of the improvement of the land but also because the mixture makes a

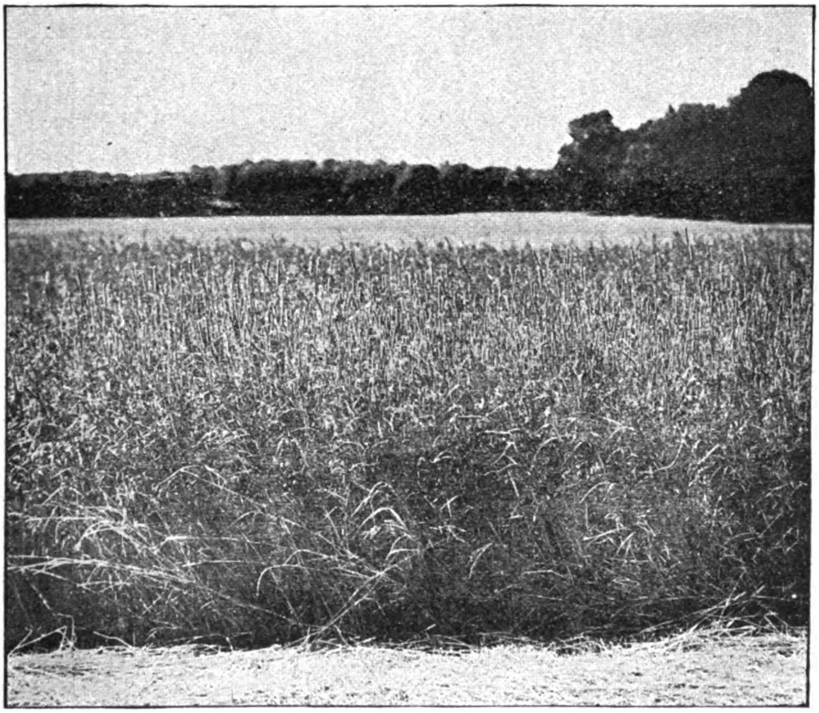

Fig. 52—SECTIONAL VIEW OF TIMOTHY FIELD
(N. J. Expt. Sta.)

much more nutritious hay than timothy alone.

Timothy should be cut for hay when well past the blooming period and many of the blooms have begun to fall. The directions for haying given for red clover apply also to timothy. (See under *Clover.*) The yield varies from 1 to 3 tons per acre. Experiments at the Michigan Experiment Station indicate that timothy hay shrinks in the barn during storage 7 to 21 per cent in 6 months, depending on its dryness when put in the barn. When seed is desired the crop should be allowed to stand until the heads are brown and the seed ripe. It should then be cut with a reaper and the bundles put in shocks and left to cure for a week or more. It should be threshed direct from the shock to avoid scattering the seed. The yield varies from 6 to 12 bushels per acre and weighs 45 to 48 pounds per bushel. For composition see *Appendix.*

Wild Rice (*Zizania aquatica*)—This is an erect annual 3 to 10 feet high. It grows in shallow water along rivers and lakes from Texas north into Canada, furnishing a considerable supply of food for water fowls and reed birds, and is often sown by hunters for the purpose of attracting such game. Relative to its culture the United States Department of Agriculture states that it grows very rapidly in 1 to 3 feet of water and matures its seeds in August or early in September. It succeeds best when the fresh undried seed is sown in the fall broadcast in 2 or 3 feet of water having a muddy bottom. If sown in spring the seed should be kept over winter in fresh running water. The dried seed is on the market. It germinates very poorly. Before sowing soak the seed in water 24 hours. The seed can be obtained from seedsmen for about 25 cents per pound. The grain is gathered to a considerable extent in the Northwest by the Indians for food. For a complete account of the propagation of wild rice and its uses see U. S. Dept. Agr. Bureau of Plant Industry Bul. 50.

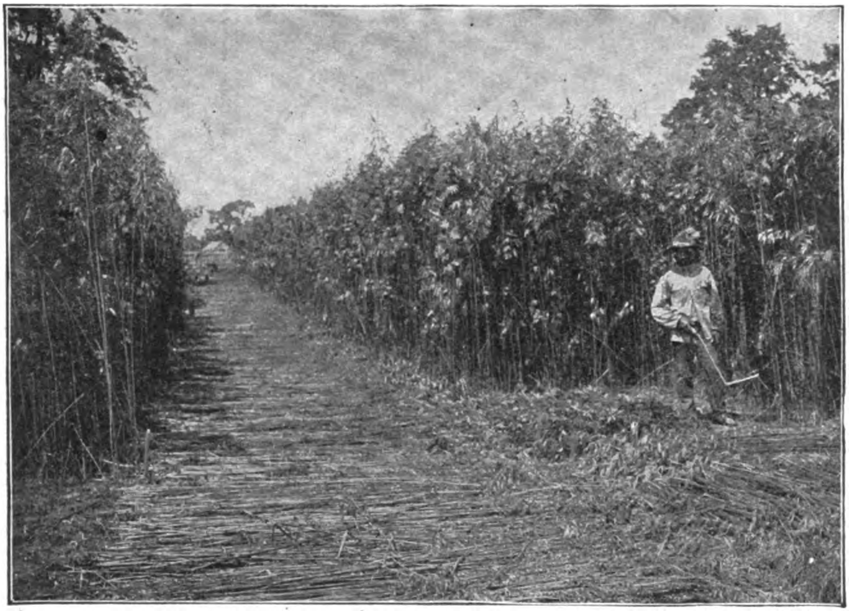

Fig. 53—CUTTING HEMP IN KENTUCKY
(U. S. Dept. Agr.)

HEMP (*Cannabis sativa*)

A fiber bearing plant of first rank. It is a hardy annual, native of Western and Central Asia, and has been grown for centuries in China. Hemp was one of the first plants cultivated in this country. It is now grown to a considerable extent in Kentucky, Illinois, New York, Nebraska and in some other localities. The principal products made from it in this country are cordage, coarse cloth and binding twine. A field of hemp is shown in Fig. 53.

Hemp is an erect annual, with male and female flowers on separate plants. It grows from 7 to 10 feet high in Kentucky. In the tropics the Indo-China variety reaches a hight of 20 to 25 feet. The plant, while withstanding frost and drouth, revels in heat and moisture and grows most luxuriantly where these conditions prevail. South of Kentucky 2 crops of hemp can be grown yearly. Under favorable conditions the crop grows 2 to 3 feet the first month after it comes up and 3 to 10 feet the next month. From seed time to maturity requires about 100 days.

The hemp fiber is from the inner bark and is closely bound together by a resinous gum. Before the fiber can be separated the gum has to be dissolved either by putrefactive fermentation, as with flax, or by some alkaline solvent. The pure fiber is white and of a silky fineness and adapted to the production of the finest linens, lawns, cambrics and threads, as well as coarser materials.

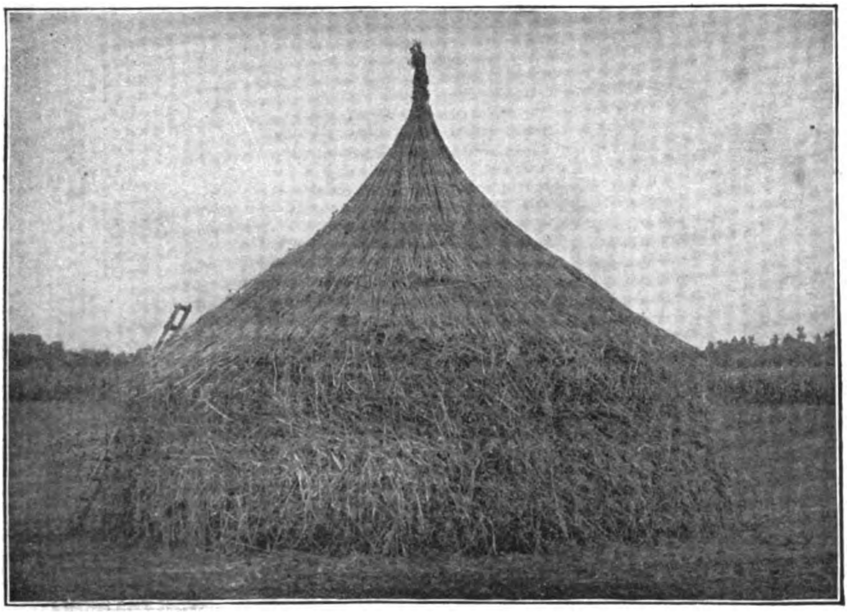

Fig. 54—STACK OF HEMP IN KENTUCKY
(U. S. Dept. Agr.)

Soils—The best soils for hemp are well drained, flat, alluvial bottoms. Good hemp can also be grown on rich uplands when special care is taken to make a deep, mellow seedbed and have the soil well supplied with moisture holding humus. Moisture is the essential factor in hemp culture, and it will endure an excess of moisture better than severe drouth.

Seeding—Hemp may be planted as early in spring as oats or rye and south of Tennessee at any time during the year. When grown for fiber it should be seeded broadcast at the rate of 3½ to 4 pecks per acre of plump, glossy 1-year-old seed and lightly harrowed in. It will not be necessary to weed the field, as is done with flax, since the rapidly growing hemp soon rises above all weeds and smothers them out.

Manuring—In manuring hemp nitrogen is the element of greatest importance when the crop is grown for fiber and can be best supplied by heavy applications of barnyard manure or by growing leguminous crops like vetch, cowpeas, etc., alternately with the hemp crop. In the South hemp and cowpeas are alternated with each other the same year. The hemp grows so rapidly that the peas may either precede or follow it. Boyce in his book on hemp states that a crop of cowpeas followed by rye or vetch, to be turned under in March, will keep a soil in good condition for hemp year after year when the ground is once properly prepared, and especially if the refuse of the hemp is returned to the land.

Cotton seed applied at the rate of 1000 pounds per acre the fall before is one of the very best fertilizers for hemp. The addition of 200 pounds of acid phosphate and 250 pounds of sulphate of ammonia, composted with cotton seed and barnyard manure, is also recommended for poorer soils. The use of expensive commercial fertilizers is not generally profitable with hemp.

Harvesting—Hemp is in the best condition for harvesting for fiber when in full blossom. It is cut with a mower, or better with a heavy self-rake reaper, which cuts the stalks close to the ground and lays them off in bunches of about an armful. It may also be cut by hand like corn. The bundles or stalks are allowed to lie on the ground until retted (or rotted) by the dew and the rain, when it is shocked like corn or tied in bundles and stacked. (Fig. 54.) Sometimes the bundles are left lying out 3 or 4 days after cutting, then turned over and left 3 or 4 days longer, after which they are tied in bundles and set up first in small shocks, then stacked and left for a few weeks to cure and then retted. It is claimed that better fiber is secured by the latter method. The yield of fiber varies from 500 to 1500 pounds per acre. Each increase of a foot in hight to the plants adds about 150 pounds of fiber per acre. An acre of hemp about 12 feet high will yield about 1500 pounds of fiber worth 6 to 7 cents per pound.

Hemp Seed—Hemp is also grown for seed. The seed is used as a bird and poultry food and for making oils to mix with paints and for soap making. For seed, hemp should be sown in rows or in hills like corn and cultivated in the same manner. Only about 2 quarts of seed will be required per acre. When the male plants begin to blossom all are removed, except one of the most vigorous, to every 3 or 4 feet of row. After these have shed their pollen and begun to turn yellow they should be removed.

The crop is harvested like corn. The stalks are stood up together to dry out partially, after which they should be put in the barn or shed having a tight floor and threshed out with a flail. The yield will vary from 10 to 30 bushels per acre. To prevent heating the seed should be stored in 2-bushel bags or kept in shallow bins with numerous compartments. For a further account of Hemp see "Hemp," by S. S. Boyce, 1900; also reports by the U. S. Dept. Agr.

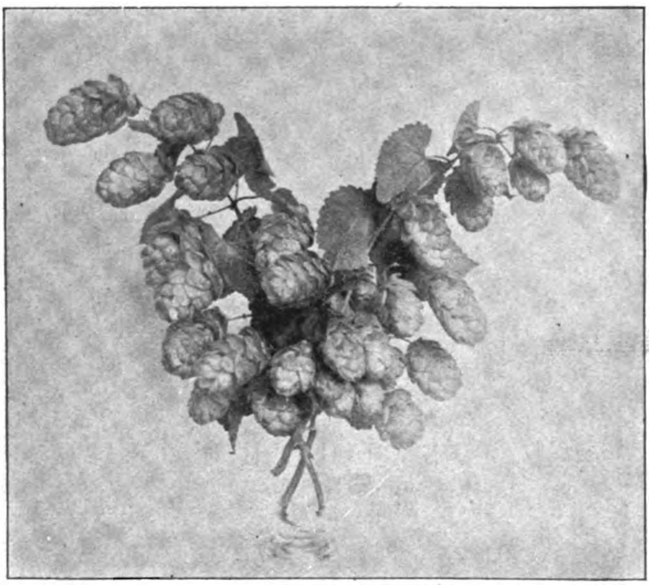

Fig. 55—CLUSTER OF FEMALE HOPS

HOP (*Humulus lupulus*)

The hop is a perennial climbing vine with harsh foliage and rough stems, which climb from 15 to 20 feet high and twine from left to right with the sun. The male and female flowers occur on separate plants. The flower is a catkin and the fruit consists of its enlarged scales, which form a cone ½ to 2 inches long. (See Fig. 55.) The ovary and bases of the scales are covered with a yellowish, aromatic, resinous substance known as lupulin. This is the essential principle of the hop and the element which gives the characteristic bitter taste to beer. Ninety-five per cent of the hops grown in the world is used in the production of beer.

The hop will grow nearly everywhere, but it is cultivated profitably only in few places. In the United States the bulk of the crop is produced in the Pacific States and New York. Small quantities are also grown in Wisconsin and some other places. Production in New York and the East is constantly decreasing, owing to more favorable climatic conditions and cheaper methods of production in Oregon, California and Washington.

Soils and Fertilizers—A rich loam soil, preferably a sandy loam, is considered the best soil for hops. It should be moist, but not wet. For ornamental purposes about the home, hops will give good results on nearly any soil. Good corn land is considered satisfactory for hops in New York. The hop yard is prepared by deep plowing and thorough harrowing. The rich virgin soils of the Pacific States as yet require little if any fertilizing, but in the East heavy applications of well rotted barnyard manure are required. This should be put on in the fall, a couple of shovelfuls being placed on each hill and worked into the soil about the plant the following spring, when the roots are grubbed and pruned. The liberal use of manure between the rows is also recommended. The hop is a rank, vigorous plant, making its growth in about 90 days, and requires plenty of plant food in the soil for its best growth. In New York from 10 to 20 tons per acre of well rotted barnyard manure are used in starting a yard. The barnyard manure should be supplemented with a liberal dressing of wood ashes.

Propagation and Setting—Hops are propagated commercially from "roots." These are 4-inch to 8-inch pieces of the underground runners or layers which start from the crown of the main root near the surface of the ground and run out several feet without diminishing much in size. Each of these root cuttings should contain 2 or more buds or eyes. While these cuttings will stand considerable abuse, they must not be allowed to dry out enough to destroy the life of them. In the dry climate of California they are set out as soon as made or "heeled in" in moist earth until wanted. The rootstock and runners of hops are shown in Fig. 56.

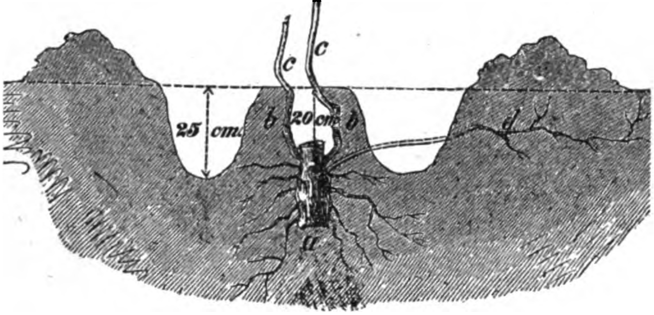

Fig. 56—THE HOP STOCK
a, **rootstock**; *b*, **vinestock**; *c*, **dead part of last year's vine cut off**; *d*, **roots separated or cut off by grubbing**

Planting out new hop yards is done in the spring as early as possible. In California this occurs in January or February, and farther north in March or April. The rows are laid out 7 feet apart each way. At the intersections 2 or 3 root cuttings are put in with a dibble or spade. These are placed about 8 inches apart and their tops placed level with the surface of the ground. They are then covered 2 to 3 inches deep with mellow soil. In every tenth hill of every tenth row a male or staminate plant should be set. In some parts of Germany, where the finest quality of hops is grown, no male plants whatever are allowed in the hop yard; but in this country it has been found advisable to use them in about the proportion as noted above. They fertilize the female plants, thereby producing seed, and thus increase the weight of the crop about 10 per cent.

In the East no crop is expected the first year and the vines are not trained up. The space between the rows is planted to some low-growing crop like potatoes or beans. It is not advisable to grow corn, since this crop shades the hops too much. In California, on the other hand, the crop of dried hops the first year may amount to 1500 pounds per acre, and the vines give their best yield the second year. Hop yards in California continue to give paying crops for 10 or 12 years, after which the crowns become large and woody, the vines start late in the spring and are less vigorous. The yard is then plowed up and reset, care being taken to see that the new rows are made midway between the old ones.

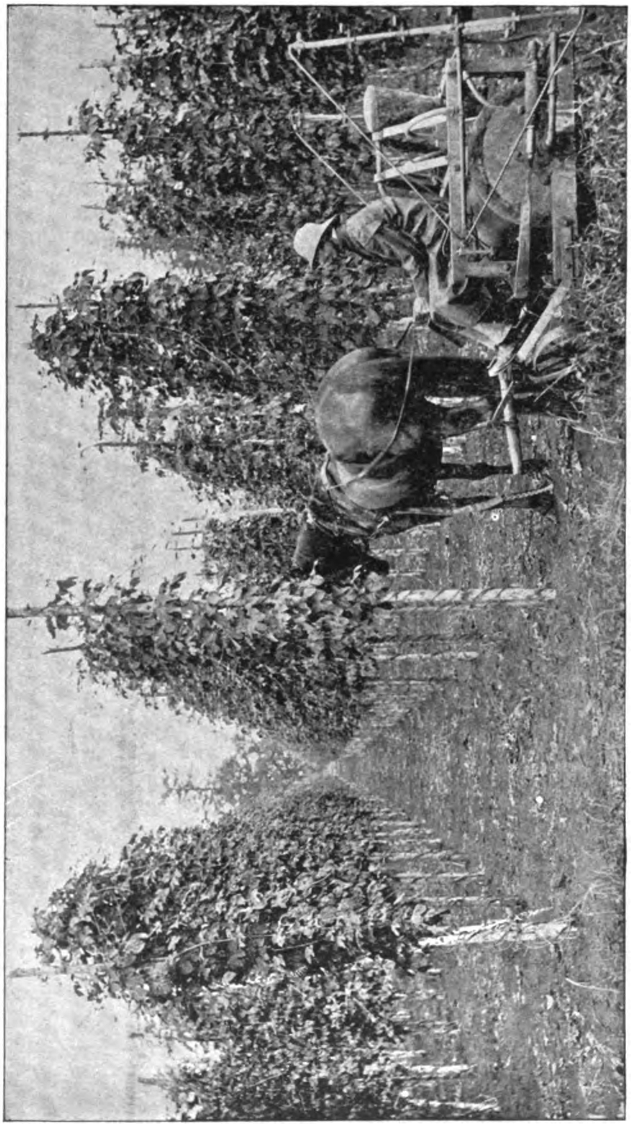

Fig. 57—POLE TRAINING OF HOPS

Pruning—Beginning with the fall or spring after the yard is set out and every year thereafter, the roots of the hop plant will require pruning. This consists in removing the earth from around the hill to a depth of 3 or 4 inches, cutting off and pulling up the surface runners and removing with a sharp knife about an inch of the old crown, together with the dead portion of the stump of the vines cut off above ground at harvesting. The vines intended for hop bearing start from this new crown. At this time diseased and weak or dead roots are removed, others being set in their places. The crown and roots are then covered again with fine soil as before.

Training—When the hop vines have reached a length of about 2 feet they require training. In the Eastern States 1 and sometimes 2 poles 15 to 18 feet long are set firmly in the ground at each hill and the vines trained to these. (See Fig. 57.) On the Pacific coast poles are gradually giving way to the high wire trellis system of training. By this method rows of stout poles are set at considerable distances apart across the yard. Wires are fastened to the tops of the poles and strings let down from the wires to the hills.

Hop Picking—This usually takes place during the latter part of August and first of September. Hops are said to be ripe and ready for picking "when the seed becomes hard and the point of the cone closes up and the hop feels hard and solid when grasped in the hand, making a rustling sound when touched." The hop vines are cut down and the hops picked by hand into boxes, baskets or in piles on blankets. They are usually picked by the hundredweight of green hops, or by the bushel. Wages for picking vary from 60 cents to $1.10 per hundredweight of green hops and average about 75 cents. A good picker will gather from 150 to 200 pounds of green hops per day.

Curing and Bleaching—As soon as they are picked hops are cured by artificial heat in kilns. This work is of a technical nature, requiring experience and judgment, and must be learned by practice. The essential features of a hop kiln are a tight building with slatted floor space for drying, heat below and ventilation above to carry off the moisture. The hops are spread on the floor in layers 18 to 24 inches deep and subjected to heat from below for about 12 hours, the temperature being kept at from 125° to 140° F. The hops are turned from time to time so that the drying may be even.

In order to produce the yellow or straw colored hop which is demanded by some markets the hops are bleached by subjecting the green hops to the fumes of burning sulphur. About 1 pound of sulphur is used to bleach each 100 pounds of green hops. The sulphur also has a preservative effect.

Cooling and Baling—After the hops have been cured and bleached they are taken to the cooling room, where they go through a sweating process, after which they are baled. The hops are usually compressed into bales 20 inches square on the ends and 5 feet long, weighing from 190 to 200 pounds. They are then sewed up in baling cloth. Hops sell all the way from 5 cents to $1.10 per pound. They cannot be grown for much less than 12 cents per pound. They decrease in value the longer they are stored, and it is generally advisable to sell as soon in the fall as a fair price is reached.

Expenses—The expenses involved in starting a hop yard in California are summarized by the United States Department of Agriculture as follows:

"For planting an acre, 2000 roots will cost $20, and the expense of planting them is $2. The high wire trellis will cost from $80 to $90 per acre, and the cotton twine for support of hops $3 per acre annually. On an average it takes more than 3½ pounds of green hops to make 1 of dry, and the cost of picking a pound of dry hops is about 3 cents. A kiln sufficient to cure the crop from 50 acres, with everything complete, will cost $3500 to $4000, and for drying, about ¾ of a cord of willow wood, worth $4 to $6 per cord, is required for every 1000 pounds of dry hops. Of crude sulphur, costing 2 cents a pound, 30 to 40 pounds must be used for every 1000 pounds of dry hops. Each bale requires 5 yards of 24-ounce, 44-inch baling cloth, which costs 8 to 10 cents per yard. Sewing twine costs 32 cents per pound. Cost of shipment, when the product is marketed in England, is about $1.50 per hundredweight."

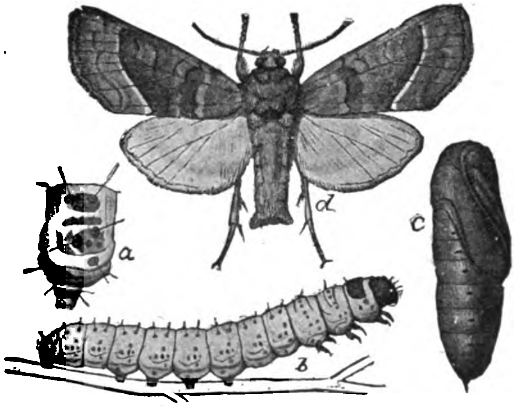

Fig. 58—HOP GRUB

(See also "The Hop," H. Myrick, 1899; U. S. Dept. Agr. Farmers' Bul. 115; Nev. Expt. Sta. Bul. No. 35.)

Enemies: MILDEW (*Sphaerotheca castagnei*) appears as white areas on both sides of the leaves. In damp weather the patches increase in size so as to cover the whole surface of the leaf. Later in the season the disease may be spread to the flowers and young cones. It may be controlled by spraying with standard fungicides or dusting with sulphur. The fungus attacks also a large variety of weeds, and therefore clean cultivation should be followed.

POWDERY MILDEW—See under *Cucumber.*

HOP GRUB (*Hydroecia immanis*) is the larva of a yellow brown moth, 1½ inches across the wings. There are 2 kidney shaped pale spots in each fore wing. The eggs are deposited at the tips of the young vines and the larva bores into the vine near the tip, causing it to drop. Later the larva drops to the ground and bores upward in the stem. During June the larva leaves the stem and feeds on the plant just below the surface of the soil. Skunks search for and destroy many of the larvae. While in the vine tips they may easily be collected and destroyed. In case of serious infestation, the soil should be removed from the roots and wood ashes or ammoniated phosphate added before hilling up. In Fig. 58 is seen *a,* a segment of larva; *b,* larva; *c,* pupa; *d,* adult. All natural size except *a.*

Hops are attacked by leaf hoppers and a number of leaf-eating caterpillars. The latter may be killed by spraying with arsenicals. Leaf hoppers may be combated by spraying with kerosene emulsion or tobacco decoction.

HOP APHIS (See under *Plant Lice*)—The treatment for this insect should begin early in the spring, before the plants have become too large and before the aphis has multiplied too extensively.

JERUSALEM ARTICHOKE (*Helianthus tuberosus*)

A yellow flowered perennial plant, growing from 8 to 10 feet high, and much resembling in appearance the wild sunflower, as seen in Fig. 59. The plant is grown almost exclusively for the underground potato-like tubers which it produces. There are white, yellow, red and purple varieties, but the white and red Brazilian varieties have generally given the best yields. The tubers, although sometimes used as a vegetable, are now grown in this country principally for stock food, particularly for hogs.

The Jerusalem artichoke will grow on almost any well-drained soil. It will thrive and produce abundantly on light sandy or gravelly soils too poor for many other crops. The main requirement seems to be a dry soil. If the soil is wet the tubers rot. The plant is drouth resistant, and as a rule remarkably free from fungus diseases and insect pests.

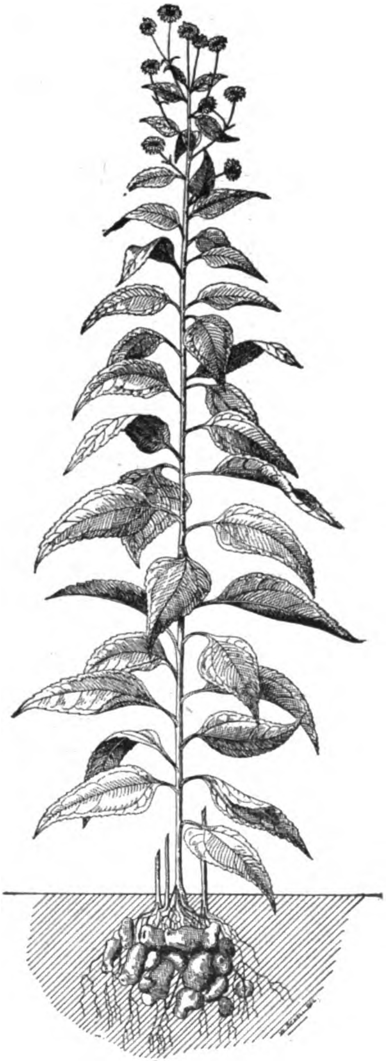

Fig. 59—PLANT AND TUBERS OF JERUSALEM ARTICHOKE

The plant is propagated like the potato by means of tubers. Whole tubers or sets are used for seed, and the hills should be spaced 3 feet apart each way. The plant is not as sensitive to frost as the potato, and may therefore be planted much earlier in the spring, or as soon as the ground will permit. Cultivation throughout the season should be about the same as that given potatoes, though it will do very well with much less attention. The crop matures in about 5 months. The tubers may be harvested like potatoes, or left in the ground over winter without harm. If grown for hog feed, they may be left in the ground and the hogs allowed to root them out. Tubers remaining over winter under the soil will as a rule grow the next spring. By this means the soil may be kept stocked, but it is usually advisable to replant each spring, or at least every 2 years. The yield is usually greater than that of potatoes, varying from 275 to 1000 bushels per acre. The tuber has about the same food value as potatoes, and is superior to turnips and mangelwurzels for feeding purposes. Some trouble is occasionally experienced in inducing the hogs to eat the tubers raw, but they soon acquire a taste for them and thrive on them. They are especially recommended for range hogs by the Arkansas Station. One acre of artichokes will keep from 20 to 30 hogs from October to the following June in good condition. They have been found an excellent substitute for a large part of the corn generally used in fattening hogs, both as regards growth and health. In feeding experiments with hogs at the Oregon Station that were given free run in the artichoke field, a pound of gain was made with each 3.1 pounds of grain fed. In other experiments it was shown that about 5 pounds of grain were necessary to make a pound of gain.

"It is not expected that Jerusalem artichokes will generally take a very prominent place in ordinary farm operations in the United States, but as a side crop, which will furnish a large amount of stock food, with a little care and cultivation, on soils too poor for many other crops, it certainly deserves the serious consideration of farmers, especially those raising hogs to any great extent." U. S. Dept. Agr. Farmers' Bul. 73.

For the composition of artichokes see *Appendix.*

JERUSALEM CORN (*Andropogon sorghum* var.)

This is a non-saccharine variety of sorghum. It is similar in general character to Egyptian rice corn and Kafir corn. It is cultivated like Kafir corn (see *Kafir Corn*), but does not withstand drouth nor yield as well as that plant. Jerusalem corn has no place on the farm in regions where corn or Kafir corn can be successfully grown.

KAFIR CORN (*Andropogon sorghum* var.)

A non-saccharine sorghum introduced from South Africa about 20 years ago and now grown to a considerable extent in Kansas, Oklahoma, California and some other South and Western States as a stock forage and grain crop. The plant grows erect 4 to 6½ feet high. The stalks are thick, short-jointed, with broad leaves somewhat shorter and stiffer than corn leaves. The heads are compact, erect, 10 to 15 inches long. A field of Kafir corn is shown in Fig. 60. The chief value of the plant is as a grain crop in semi-arid regions where the soil is too poor or the drouths too severe for corn.

The crop is adapted to all soils, but makes its best development on rich corn lands. Profitable crops of Kafir corn can also be produced on soils too poor for corn. During drouths the Kafir may cease to grow and the leaves curl up, as do corn leaves, but they remain green and with the first rain start into growth again. If the stalks are cut they sprout up again, producing a second and even a third crop.

In Michigan, North Dakota, New Jersey and the Northern and Eastern States generally Kafir corn has given poorer yields of both forage and grain than Indian corn. Generally speaking, Kafir corn has no place in Northern humid agriculture. In such regions corn yields more and is a better crop to feed.

Seeding—The seedbed for Kafir corn should be prepared exactly as for corn. The finer the tilth the better. The best yields have been obtained in Kansas and Oklahoma when the seeds were drilled in 3 to 5 inches apart in rows 3 feet apart. It is better to seed too thick than too thin. The experiment stations have seeded the crop very successfully with a grain drill by leaving the first and fifth feeds open and closing the others. By drilling a little on bare, hard ground the feed bar can soon be adjusted so that about the right amount is sown. It should be drilled in about as deep as wheat. From 6 to 7 pounds of seed is sufficient to plant an acre. Listing may be practiced with Kafir corn. The slow, weak growth of the crop for the first 6 weeks after planting makes this practice generally undesirable, except possibly on warm soils and in late planting. The seedbed should be pulverized just before planting in order to kill all weeds.

Kafir corn grows best in warm weather, and as a rule should not be planted until after corn. If planted earlier, when the ground is cold, much of the seed is liable to rot and reseeding become necessary.

The best seed, according to the Kansas Station, is that from long, closely compacted heads which have been kept dry over winter. If the seed is threshed and stored in large quantities it heats sufficiently in damp weather to destroy its germinating power. Poor stands, it is stated, are common every year all over the State from this cause.

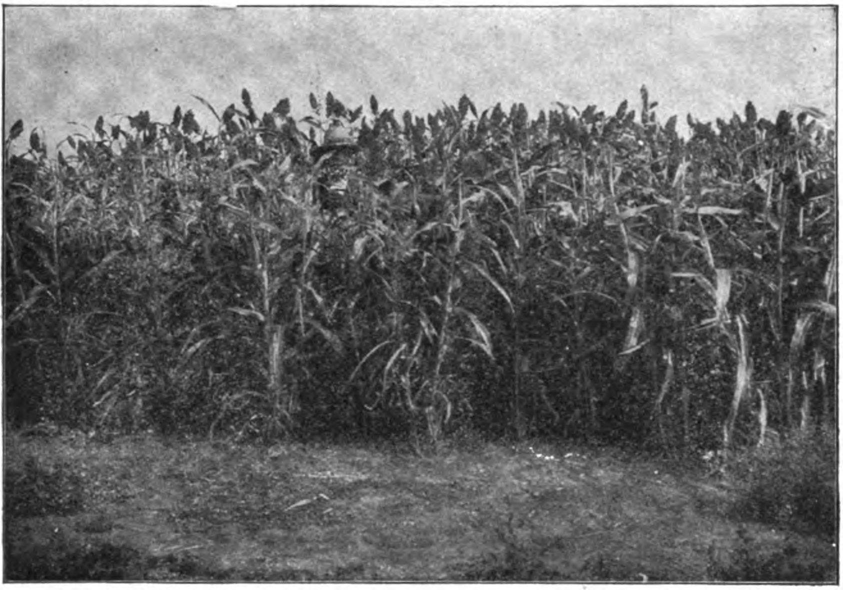

Fig. 60—KAFIR CORN GROWN IN SOUTH DAKOTA

The same cultivation is required for Kafir corn as for corn. The roots of the plant extend from row to row 4 to 5 inches below the surface. Only shallow cultivation should be practiced.

Harvesting—Kafir corn matures its seed in from 12 to 14 weeks. The plant remains green, however, until late fall. If both grain and fodder are wanted the crop should be cut as soon as the seed is ripe and put in large shocks to cure. The corn binder is the most convenient machine for cutting the stalks; but any of the methods of corn cutting applies equally to Kafir corn. For stock horses and cattle the shocks may be hauled directly to the feed lot; but when animals are to be fattened the grain should be threshed and ground. Kafir corn cut and shocked in September will not be cured sufficiently for threshing before November.

Methods for threshing Kafir corn have not yet been perfected, but the cheapest method at the Kansas Station was to place the bundles on a block and chop off the heads with a broad ax, after which they were run through a separator, putting a board in place of the concaves to avoid splitting the seed. Threshed Kafir corn grain stored in bins is almost certain to heat in damp weather. It should be carefully watched and shoveled over when necessary.

Varieties—There are 3 varieties of Kafir corn in general cultivation in the United States, the red, white and black-hulled white. The latter is also known as African millet. The red and black-hulled white are the heaviest yielding varieties. The red variety is believed to be a little hardier and earlier than the black-hulled white, but does not yield quite so heavily. For 11 years at the Kansas Station red Kafir corn has yielded at the average rate of 46 bushels per acre, and for 3 years the black-hulled white variety has yielded at the rate of 43 bushels per acre. For the whole 11 years corn yielded under like cultural conditions but 34½ bushels per acre. The highest yield for any one year was, red Kafir corn 98 bushels, and corn 74 bushels per acre. A bushel of Kafir corn weighs 56 pounds.

Use—Kafir corn grain is used like corn for fattening hogs, cattle, poultry and all farm stock, though pound for pound it is not so valuable for fattening purposes, nor does it appear to be so greatly relished. According to the North Carolina Station mature Kafir corn contains 16.23 per cent water, 2.02 per cent ash, 6.92 per cent protein, 6.79 per cent fiber, 65.18 per cent nitrogen free extract, and 2.86 per cent fat. (See also *Appendix.*) A bushel of Kafir corn produced 10.6 pounds of pork at the Kansas Station and a bushel of corn 11.9 pounds. Owing to the greater yield of Kafir corn an acre produced 487 pounds of pork, while an acre of corn produced but 410 pounds. For hogs the best results have been secured when alfalfa, skim milk or soy beans have been fed with the Kafir corn. Fed on Kafir corn alone the hogs soon got so they loathed it.

With fattening steers at the same station Kafir corn has not been found quite equal to corn, but when fed with alfalfa it made the cheapest combination for dairy cows. It was fed in the proportion of 20 pounds of alfalfa to 8 pounds of Kafir corn. Kafir corn meal is somewhat constipating and has been found especially valuable to feed with skim milk to calves. For horses, the grain may be fed in the head. For colts and horses not working the stalks and heads may be fed together.

At the Oklahoma Station coarsely ground Kafir corn contained 40 per cent more digestible matter than the whole grain. Generally, for all farm animals, the grain should be ground. Chickens at the Oklahoma Station, however, digested the whole grain more completely than ground grain. Soaking either the whole or ground grain does not increase its feeding value. For hogs, the Kansas Station has found it advisable to put the dry ground grain in the trough and pour water over it.

Kafir corn fodder without the grain much resembles cornstalk fodder after the ears have been removed. It is used as a coarse fodder in the same way. As a hay crop it is hardly as valuable as some of the sweet sorghums. It is not so palatable and the yield is lighter. Grown for hay 1½ to 2 bushels of seed per acre sown broadcast are used and the crop cut when the seed is in the dough stage.

Danger from Second Growth—The green second growth that springs up after Kafir corn is cut can usually be pastured with safety, but sometimes sudden deaths occur among the animals so pastured. Frequently, bloat is the cause but often the symptoms are those of acute poisoning. English investigators, and more recently the Nebraska Experiment Station, found a satisfactory explanation of the cause of such deaths. When the first or second crop is checked in its growth prussic acid is developed in fatal quantities. The cured second growth fodder can be fed with comparative safety, or the stock may be pastured without danger after the crop has been killed by frost. For enemies see under *Sorghum*. For a further account of Kafir corn see U. S. Dept. Agr. Farmers' Bul. 37; Kan. Expt. Sta. Bul. 93; Okla. Expt. Sta. Bul. 35; Neb. Expt. Sta. Bul. 77.

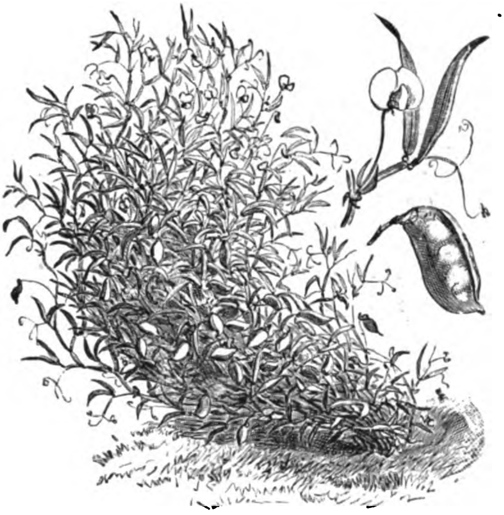

Fig. 61—SPANISH LENTIL

LENTIL (*Lens esculenta*)

An annual leguminous plant much grown in Europe for its round, flat seeds, which are boiled for soup or cooked like beans. The plant is little grown in this country. It requires a warm, sandy soil, and should be planted at about the time soup beans are. Sow in drills 18 to 24 inches apart and harvest when the stems begin to yellow. The seed may be beaten out with a flail after the pods are dry.

A plant, flower and seed pod are shown in Fig. 61.

LESPEDEZA (*Lespedeza striata*)

This is an annual leguminous forage and green manure crop, grown to a considerable extent in the South, but too tender for culture north of the Ohio river. It was introduced from Asia about 1850 and has been found of considerable value in a number of Southern States as a summer pasture plant on poor clay soils. It is seeded at the rate of about 12 pounds per acre and reseeds itself from year to year unless too closely pastured. The plant grows 15 to 24 inches high on good soil and yields a heavy crop of nutritious hay. (Fig. 62.) The plant is also called Japan clover.

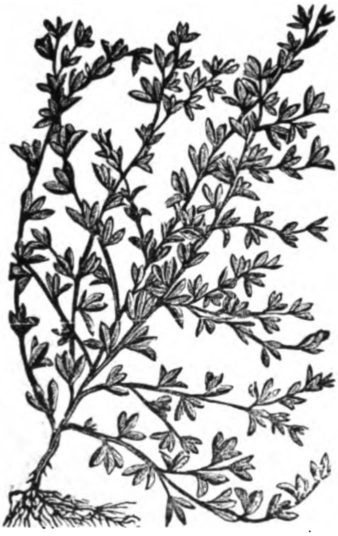

Fig. 62—LESPEDEZA

LUPINES (*Lupinus* spp.)

These plants belong to the pea family. There are about 100 species, mostly annuals and herbaceous perennials. A few have been brought under cultivation as forage crops, but primarily for green manuring. A large number are also grown in gardens for their terminal racemes of bright colored flowers. About 70 species are native to western North America, a few to eastern North America and to the Mediterranean region. Lupines are not cultivated to any extent in the United States; but in Montana, Idaho and some other Western States the species *L. leucophyllus*, *L. sericeus* and *L. pseudoparviflorus* grow wild in such abundance that they are cut in enormous quantities for hay. The plant contains an alkaloid that sometimes poisons stock. The alkaloid is most abundant in the ripe seed. The green crop may be pastured throughout the season; but it should not be cut for hay until after the pods have burst open and the seed fallen out. This takes place the latter part of August. Sheep are more susceptible to lupine poisoning than horses or cattle. (See *Poisonous Plants.*)

In Europe lupines are cultivated to some extent for forage, but mostly for green manure. The yellow lupine (*L. luteus*) is most extensively used for this purpose, and to a lesser degree the blue lupine (*L. angustifolius*) and white lupine (*L. albus*). A lupine plant and flower are seen in Fig. 63.

The lupines are especially valuable as green manure crops on light, sandy soils too poor to grow anything else. The yellow lupine is reported to grow even in sand dunes along the coast. They are not suited to calcareous soils or wet situations. Seed of this variety should be sown in May or June in drills 9 to 15 inches apart at the rate of 1½ to 2 bushels per acre.

At the California Station spring sown lupines were a failure; but when fall sown heavy crops were obtained. Thus planted they were a valuable winter cover and green manure crop. On clay soils it was found that lupines would tolerate twice as much lime as on sandy soils. For strongly calcareous soils the pink lupine (*L. pilosus roseus*) and large blue (*L. pilosus coeruleus*) are recommended.

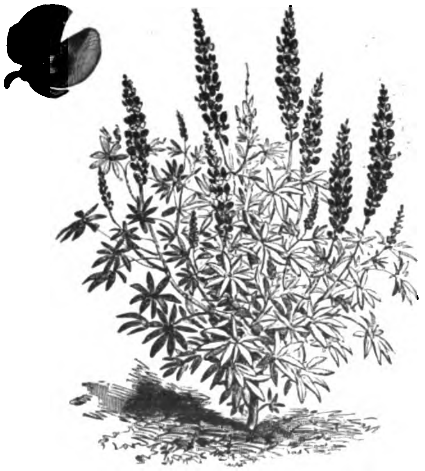

Fig. 63—LUPINE

It is only for special situations that lupines will have any value for American farmers over other leguminous plants.

MEADOWS

Land seeded down to grass is known either as a meadow or a pasture. If the grass is cut for hay the field is called a meadow; if it is used continuously for grazing stock it is a pasture. The grasses most in use for these two purposes are discussed under *Grasses.* (See *Grasses,* also *Clover.*)

In meadows it is important that grasses be used that mature at about the same time. If the land is such that bunch grasses grow best, grasses of more spreading habit that will grow between should be mixed with them. Clovers should also be used to improve the quality of the hay. In permanent meadows such grasses and clovers should be sown together as will furnish an abundance of herbage throughout the whole season. The following mixtures are frequently seeded together for hay in the Eastern States: (1) Timothy 16 pounds, redtop 16 pounds, red clover 4 pounds per acre. (2) Redtop 13 pounds, orchard grass 18 pounds, meadow fescue 9 pounds and red clover 4 pounds per acre. (3) Tall oat grass 28 pounds, red clover 8 pounds per acre.

For pastures the following mixtures are suggested: (1) Kentucky blue grass 8 pounds, white clover 4 pounds, perennial rye 9 pounds, red fescue 3 pounds, redtop 8 pounds per acre. (2) For wet pastures seed a mixture of 14 pounds redtop, 8 pounds alsike clover, 6 pounds creeping bent and 12 pounds perennial rye grass per acre. (3) On light, sandy soils seed a mixture of 20 pounds red fescue, 10 pounds redtop, 8 pounds Kentucky blue grass and 2 pounds white clover per acre.

Meadow and pasture grasses respond promptly to fertilizers. A good dressing of barnyard manure will tend to rid meadows and pastures of mosses, daisies, etc., and greatly increase the yield of hay or pasture. On acid soils at the Rhode Island Station applications of lime at the rate of about 1000 pounds per acre more than doubled the yield of hay, besides bringing in desirable grasses like timothy, blue grass, orchard grass, brome grass and clover. The use of nitrogenous fertilizers is especially desirable with grasses, since large stems and leaves rather than the production of seeds, is sought. Phosphoric acid is the fertilizer element of next importance and potash least. See also U. S. Dept. Agr. Farmers' Bul. 66; Tenn. Expt. Sta. Buls. Vol. XI, Nos. 2, 3 and 4.

MEXICAN CLOVER (*Richardsonia scabra*)

This plant is not a true clover, as the name would suggest, but is somewhat similar to the clovers in habit. (See Fig. 64.) It is an annual creeping plant, native to Central America and Mexico. It has become a weed in some of the Gulf States. It is seldom or never cultivated, but comes on along with crab grass after corn and cotton crops are laid by. On rich soils it may produce a ton or more of hay of fairly good quality. It thrives best on sandy soils. In Florida orange orchards it is considered of value as a cover crop and to turn under for green manure. It is not probable that this crop will ever become cultivated to any great extent in this country, since there are a number of other crops that surpass it for both forage and green manure.

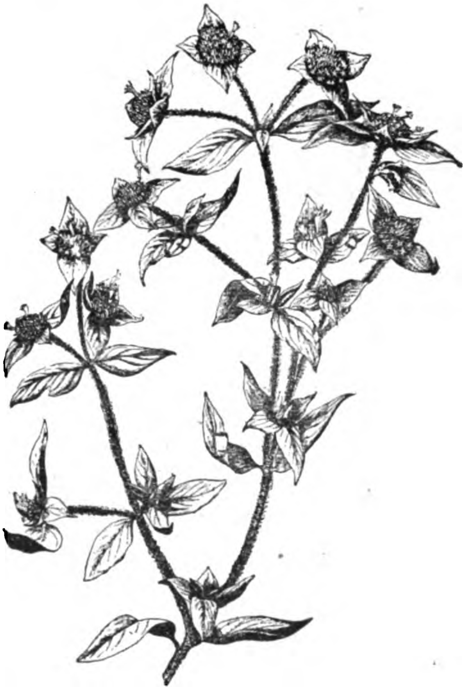

Fig. 64—MEXICAN CLOVER

MILLET

This is a general name for a large number of species and varieties of grasses. In this country the millets are grown principally for forage; but in southern Europe and the East the seed is extensively used for human food. There are 3 principal groups of millets cultivated in this country, the foxtail millets (*Chaetochloa italica*), characterized by a compact, bristly foxtail like head, and including such varieties as Common, German, Hungarian, and Golden Wonder millets; the barnyard millets (*Panicum crus-galli, P. colonum,* etc.), characterized by dense paniculate heads and including true Barnyard millet, Shama millet or Jungle rice, and Sanwa millet; and broom corn millets (*Panicum miliaceum*), characterized by bushy heads produced at the ends of long branches, and including such varieties as Broom Corn or Hog millet, Manitoba, California Beauty, etc.

Millet is used in this country principally as a catch crop for hay when the regular hay crop fails. It is seldom grown as a primary crop. It is valuable because it can be sown in the spring after it is found that the seeding of permanent grass has failed or the clover crop has been winter-killed. A crop can be successfully grown after it is too late to plant corn.

Soil and Seeding—Millet requires warm weather for its successful growth. Frost kills it about as easily as Indian corn. The best soil for millet is a rich, well-drained sandy loam. On heavy clays or wet lands it will not thrive. Millet is hard on the land, not because it withdraws more plant food from the soil than many other crops, but because of its shallow feeding root system it draws most of its plant food from near the surface of the soil.

Millet is usually seeded after corn is planted, the last of May or first of June. In the South it may be sown as late as August. The seedbed should be well plowed and harrowed and free from clods. When grown for hay about ½ bushel per acre of Hungarian grass, German or Common millet is required. The Broom Corn millets require about ¾ bushel per acre. For seed only about half these quantities need be sown. The seed may be either drilled in or broadcasted and lightly harrowed in. For soiling purpose the crop will be ready for use in about 60 days.

Harvesting—Millet should be cut for hay between the time of complete heading out and late bloom. Cutting should never be delayed until the seeds begin to ripen, owing to possible injurious effects it may have on the animals eating it. (See *Horses.*) There is no danger whatever in feeding the green or ensiled forage or hay made before the seed matures. For soiling and silage it may be cut a little later than for hay. After cutting for hay the millet should be allowed to wilt for a few hours, then tedded once or twice, after which it should be put into small cocks and allowed to cure 2 or 3 days before hauling to the barn or stacking. Millet stems are large and succulent. The crop is cut greener than most hays and requires more drying, principally in the cock, than other hays. Otherwise it is no more difficult to cure than clover and will endure much more exposure to rain and dew without serious injury. The hay is sometimes cut with a self-binder and the loosely tied bundles cured by setting up two and two in long shocks running north and south, and thus exposed to the full sunshine. This is an easy way of handling the crop. The yield of cured hay varies from 1½ to 3½ tons per acre.

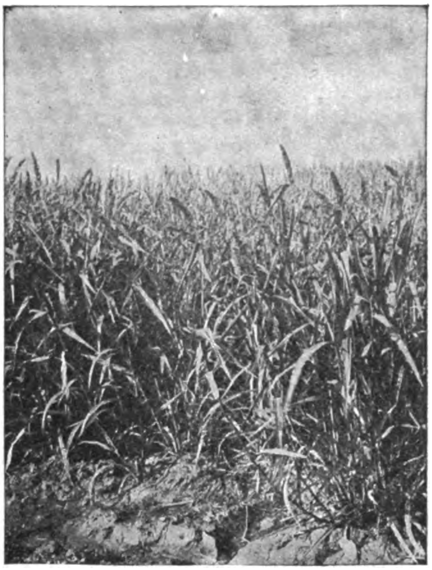

Fig. 65—JAPANESE MILLET

Millet for seed is harvested like any small grain crop. One of the best methods is to cut with a self-binder when the seed is in the late dough stage and stand the bundles two and two in long shocks. When dry enough thresh from the shock. The yield averages about 20 to 25 bushels per acre and varies from 5 to 75 bushels per acre. A bushel varies in weight from 45 to 50 pounds.

Varieties—There are many varieties, and their relative values have not yet been definitely worked out except in a general way. Of the foxtail millets, Common millet is most grown and probably better known than any other variety. It is one of the smallest but earliest millets and is especially desirable for sowing on the poorer soils or where the seasons are short, or for sowing late in the season. Hungarian millet yields about the same as Common millet. The seed of this variety is characterized by having a large proportion of dark colored grains. German millet is considerably later than either, is less drouth resistant and makes a somewhat coarser hay. Golden Wonder is especially valuable for the production of seed, leading all the other foxtail millets in this respect. It is especially susceptible to drouth, however, and is therefore less generally grown than other standard sorts. A field of Japanese millet is seen in Fig. 65, and the heads of several varieties in Fig. 66.

Of the barnyard millets true Barnyard millet is considered most valuable.

The Broom Corn millets withstand drouth the best of the millets. They are favorite sorts in the Northwest, where drouth and short seasons prevent the cultivation of Indian corn. The forage of these millets does not have the laxative and diuretic action upon animals eating it that sometimes occurs with the foxtail millets. Further notes on varieties of millets may be found in Mich. Expt. Sta. Bul. 117 and U. S. Dept. Agr. Farmers' Bul. 101. For composition see *Appendix.*

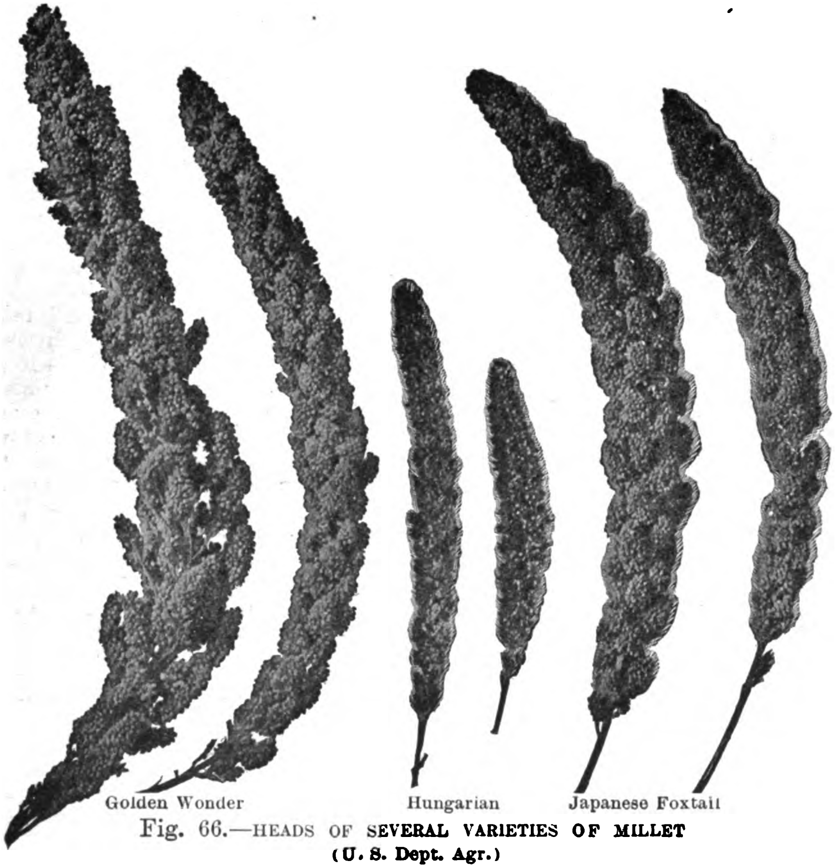

Fig. 66.—HEADS OF SEVERAL VARIETIES OF MILLET
(U. S. Dept. Agr.)

Use—Millet seed is used in enormous quantities in India, China, Japan and some parts of Europe as human food. Here it is not grown for this purpose. The seed is fed to fowls and birds and to young stock. Hogs do especially well on it. It should be ground before feeding to animals.

The cured hay is not quite though nearly as valuable as timothy. The foxtail millets if cut when ripe produce a hay of poor quality, which is liable to induce disorders when fed continuously to horses for any considerable period. When cut at the proper time, as previously noted, and properly cured, no harm seems to result from its use. The millets make good pasture crops. The Hungarian and Common are best for this purpose, since they sprout up from the roots.

Pearl Millet (*Pennisetum spicatum*)—This forage plant is also known as Penicillaria, Mand's Wonder forage plant, African, East Indian, Egyptian and Japan millet, etc. It is probably native to tropical Africa. It was introduced into the United States about 50 years ago and has been cultivated to a limited extent ever since then, more particularly in the Southern States. The plant is an erect succulent grass 6 to 15 feet high, with very leafy stems terminating in a cylindrical spike, 6 to 14 inches long, as seen in Fig. 67. It is grown as a soiling crop and for hay and next to teosinte is perhaps the heaviest yielding forage plant cultivated in the United States. Pearl millet revels in rich warm alluvial soils; but can be grown on most corn lands. It is easily killed by frost and should therefore not be planted until the season for corn planting. The ground should be well prepared and again cultivated just before seeding to destroy weeds. If grown for soiling, sow in rows 3 feet apart and 6 inches apart in the row. For hay seed in rows 18 inches apart and about 4 inches apart in the row. With good seed about 4 pounds per acre will be required for the thinner planting and 8 to 10 pounds for the thicker planting. When the crop is broadcasted for hay about a half bushel of seed should be sown. The seed should be covered only about ½ inch deep. Shallow level cultivation as for corn should be practiced.

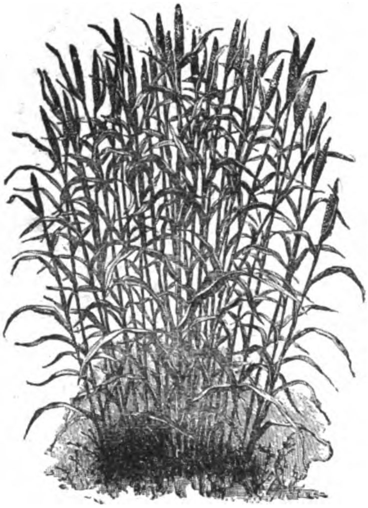

Fig. 67—PEARL MILLET

At 11 experiment stations where pearl millet has been grown the yield has varied from 5 to 40 tons of green forage per acre and from 1.5 to 16.4 tons of hay. The number of cuttings varies from 1 or 2 in the Northern States to 3 to 5 in the Southern States. The chief value of pearl millet is as a soiling crop. For this purpose cutting should commence when the crop is 3 to 4 feet high. It starts more readily into a second growth if cut 4 to 5 inches high. For hay it should be cut just as the heads are appearing. The green plant contains 75 to 80 per cent of water and is therefore difficult to cure into hay. It is handled in the same way as corn fodder. The stalks are cut either by hand or machinery and bound into small bundles and shocked. The plant appears very palatable to stock. While it yields perhaps heavier than the sorghums it is not likely to prove more satisfactory on most farms and will seldom prove as desirable or as valuable as corn. For a further account of this plant see U. S. Dept. Agr. Farmers' Bul. 168, upon which this account is based.

MILO MAIZE (*Andropogon sorghum* var.)

A non-saccharine sorghum. The plant tillers abundantly and produces tall slender and succulent leaf stalks. The seed is in a compact sorghum-like head. Two varieties are in cultivation, the White Milo (Fig. 68) and the Yellow Milo or Rural Branching sorghum. (Fig. 69). The White Milo maize requires a long season to mature seed and the yellow variety is somewhat earlier. Both sucker abundantly and produce a considerable amount of good forage, but do not surpass in this respect the various sorghums. Milo maize is cultivated like Kafir corn (see *Kafir Corn*), but is not as drouth resistant. Tests at a number of experiment stations indicate that for forage purposes it is surpassed by the sorghums, corn and Kafir corn.

OATS (*Avena sativa*)

This crop ranks second in the number of bushels and third in acreage of the grains grown in the United States. It is the hardiest of the cultivated cereals. Oats are grown in every State in the Union and north into Canada and Alaska. The group of States from New York and Pennsylvania west to Minnesota and south to Kansas produces about ¾ of the entire crop grown in this country. A hot, dry climate is not suited to the oat crop, hence in some Western States it is a grain of minor importance. The oat is used both as a human food and for stock, especially horses.

Soils and Preparation of Seedbed—Oats are successfully grown on a wide range of soils, such as poor clays, sandy loams, peaty soils and even marshy and undrained land; but prefer a well-drained, fertile clay or a clay loam, and give the heaviest yields on such soils. The seedbed should be prepared by plowing rather than disking or harrowing. Heavy lands, especially in the North, have generally given the best results with oats when fall plowed. In Kansas, when oats followed corn, the best average results for 5 years in succession were obtained from spring plowed land. Subsoiling for oats is of doubtful value. Generally it will not pay. A medium compact seedbed, as shown by experiments in 7 of the chief oat-growing States, seems to be especially desirable. Rolling the seedbed either before or after seeding is considered good practice by the Michigan Station for light soils, and rolling increased the yields at the Oklahoma, Wisconsin and Minnesota Stations. Oat plats packed with Campbell's subsurface packer yielded 4 bushels per acre more than plats not packed at the Kansas Station. On heavy clay soils rolling is considered of doubtful benefit by the Ohio Station.

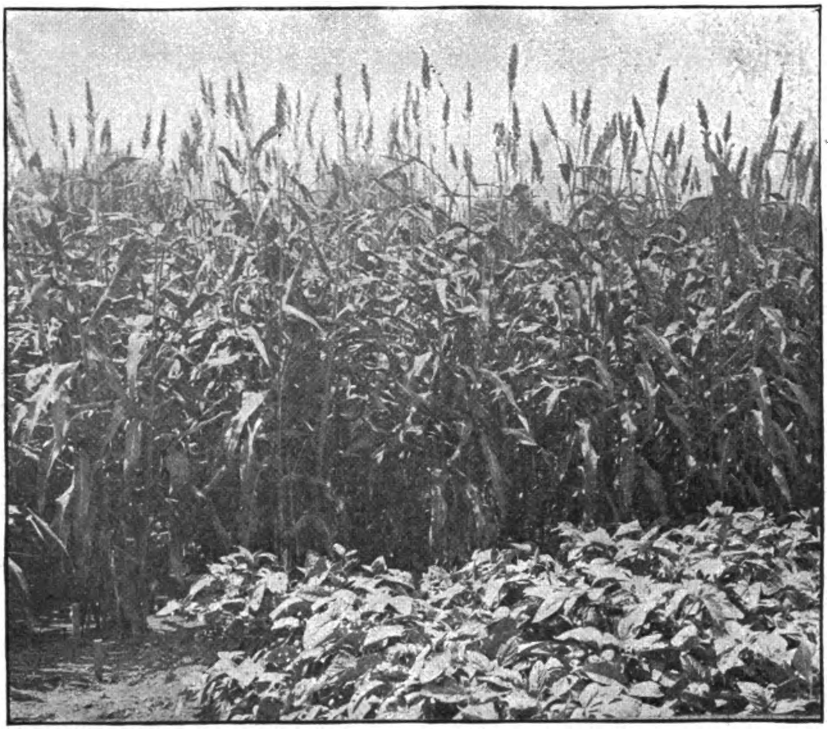

Fig. 68—WHITE MILO MAIZE

Seeding—The time of planting will vary with the season and latitude. In many of the Southern States oats may be sown either in the fall or the spring. At the Alabama Station Red Rust Proof oats sown in November produced 9.8 bushels of grain and 531 pounds of straw more than when seeded in February or March. In Georgia fall seeding is recommended in preference to spring seeding on land fertilized with a complete fertilizer. Oats can be profitably sown for forage in Louisiana in October. Sowing winter oats about September 1 is recommended in Maryland. The results of tests at the Indiana, Iowa and New York State Stations show that it is unwise to attempt to grow winter oats in these latitudes. The first and second weeks in March, in Kansas, and the last of March, in Illinois, have proved the best dates for seeding during a number of years. At the latter station the weight per bushel uniformly decreased with the lateness of the seeding. In Pennsylvania seeding from April 15 to 27 has proved most satisfactory. In general in the North plant oats as early in spring as the weather is settled.

A summary of all the experiments on different depths of seeding goes to show that for the best yields of both grain and straw the seed should be put in about 2 inches deep. At the Minnesota Station the largest yield of straw was obtained when the oats were seeded 1½ to 2 inches deep and the largest yield of grain at depths of 2½ to 3 inches. The yield of oats at the Illinois Station regularly decreased as the depth of planting increased from 1 to 6 inches.

The experiments at the agricultural experiment stations show that the rate of seeding oats may vary from 2 to 3 bushels per acre. On the better lands the larger amounts should be sown, while on the poorer lands the smaller amounts should be used. Oats are sometimes mixed with other grains, but seeding oats alone has usually resulted in greater yields of both grain and straw than where seeded in mixtures with peas or wheat. When oats and peas are grown together the North Dakota Station considers 2 bushels of oats and ½ bushel of peas a good mixture. If oats and peas are grown together for hay they may be harvested in time to seed the land to Dwarf Essex rape for fall sheep feeding, and the cost of one crop will about pay for putting in and harvesting both. As to the merits of broadcasting and drilling

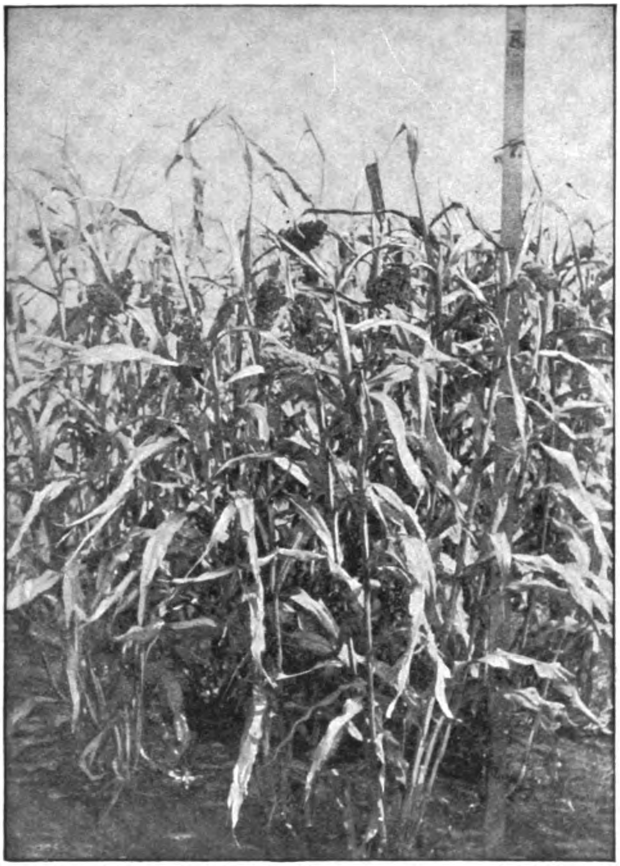

Fig 69—YELLOW MILO MAIZE

oats, the majority of the stations favor drilling.

A number of experiments have been made as to the value of light, medium and heavy oats for seeding. At the Kansas Station the average yields for 8 years were: For light oats, 27.5 bushels per acre; medium oats, 28.89 bushels; and heavy oats, 30.9 bushels. The Kansas Station states, with reference to this point, that "light, inferior seed is certain to produce less than seed of fair quality, but between a fair quality of seed oats and heavy sifted seed there is not very much difference." At the Ohio Station new seed oats gave better yields than seed 1 year old, and seed at the Illinois Station showing perfect germination yielded 9 bushels more per acre than seed having a germination between 74 and 90 per cent perfect.

Relative to the value of oats and peas as a forage crop, the New York Cornell Station (Bul. 135) states as follows:

"Ranking next to corn as a forage crop and a close second, comes oats and peas. In the 2 years in which we have been conducting experiments in the production of forage this combination has proved itself well worthy of a place on every farm where stock is kept. It is valuable either for pasture, for cutting as a soiling crop, or when allowed to mature it may be cured for hay, making a most valuable article. When planted in succession of about 2 weeks, the first planting being as early in the spring as conditions will permit, a succession of highly nutritious forage is produced which is greatly relished by stock. If a more general use was made of oats and peas for summer feeding it would greatly decrease the expense of the production of milk and the cost of maintaining cattle and economize land very materially. A highly nutritious forage would be obtained, rich in protein and furnishing nearly a balanced ration for milch cows. A large amount can be produced per acre, and it may be grown from early spring to late fall. A slight freeze does not affect it, and it may be sown in the spring before frosts are over, and the late forage frequently remains in good condition until December. The oats and peas at this station sown August 1, were in good condition for feeding until a severe freeze on the night of December 2 cut them down. For late forage, however, barley and peas are recommended instead of oats and peas. For sowing any time after July 1 substitute barley for oats. The reason for this is that in late summer barley makes more rapid growth, is less likely to attacks of rust and other fungus diseases than are oats."

Manuring—In many Northern systems of rotation, oats follow corn. Where the corn has been heavily fertilized with barnyard manure and well cultivated, it makes an ideal preparation for oats. Oats after leguminous crops, like clover, peas, alfalfa, velvet beans, beggar weed, etc., also give greatly increased yields. At the Alabama Station, oats following velvet bean vines and stubble plowed under yielded at the rate of 33.6 bushels per acre; after cowpea vines and stubble, 31.6 bushels; while the same season after non-leguminous crops, like German millet or crab grass and weeds, the yield averaged but 8 bushels per acre. Experiments at many other stations with commercial fertilizers, as well as farm manures, give results all going to show that the oat crop is greatly benefited by applications of nitrogenous fertilizers, and if the manure is well rotted nothing is better for this purpose than barnyard manure. Next in importance to nitrogen on most soils comes phosphoric acid. As a source of nitrogen other than barnyard manure and leguminous plants, nitrate of soda has generally proved most satisfactory, though in some instances in the South cottonseed meal has given the best results. The nitrate of soda is best applied as a top-dressing on oats in the spring. From 50 to 200 pounds may be used any time after the plants are well started. At the Alabama Station the best results were secured by applying when the oats were well branched and some of the leaves were 6 inches long, rather than applying later. The Georgia Station gives the following ideal fertilizer formula for oats in that State: At seeding time in the fall (October or early November), 200 pounds of acid phosphate, 50 pounds of muriate of potash, 25 pounds of nitrate of soda and 200 pounds of cottonseed meal; in the spring an additional top-dressing of 75 pounds of nitrate of soda. On acid soils lime has been found especially beneficial for oats, and at the Alabama Experiment Station, on a fertile soil, limed fields gave greatly increased yields.

Harvesting—At the Illinois Agricultural Experiment Station "slightly better results were obtained when oats were harvested while still green and the kernels mostly in the dough stage than when the straw was mostly yellow and the kernels hard. When the oats were allowed to mature fully the results were distinctly less satisfactory. When the sheaves were bound and shocked at once the yield was somewhat better than when the cut straw was allowed to dry thoroughly before the sheaves were bound." At the Kansas Experiment Station oats cut in the dough stage yielded 17.85 bushels; cut in the hard dough, 21.8 bushels; and cut when ripe, 26.37 bushels per acre. As a general rule, oats should be harvested when the lower part of the stalk has turned yellow. At this stage the plant has ceased to draw nutriment from the soil and further growth consists in the maturation of the seeds. It is generally conceded that if the grain is cut at this time the straw is better for fodder and other purposes. If the cutting is delayed until the seed are entirely ripe considerable loss is liable to occur from shelling out, and the quality of the straw for feeding purposes is considerably impaired.

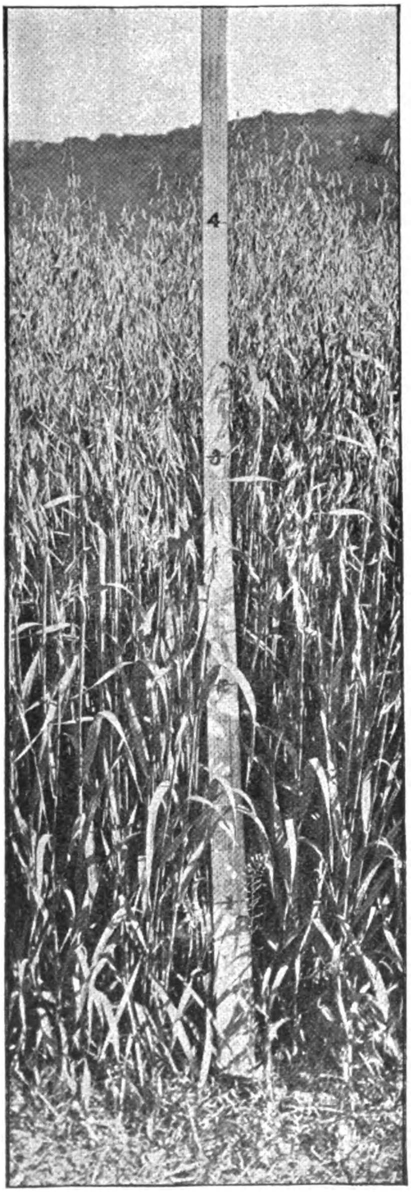

Fig. 70—VIRGINIA GRAY OATS
(Tenn. Expt. Sta.)

The value of rolling oats to prevent lodging has been tested by the Minnesota Station. A roller was run over a field when the oats were 8 inches high, and over another when the oats were 12 inches high. The oats rolled when 8 inches high stood up somewhat better than those rolled when 12 inches high or those not rolled. The oats on the rolled plats ripened 2 days later, were not so tall by a few inches, and yielded less grain and less straw than oats not rolled. At the Iowa Station a part of one field was cut back with a mower to the base of the third leaf, when most of the plants were showing 5 leaves. Another part was cut back down to the second joint from the ground. At harvest time plants cut high yielded 58.2 bushels per acre; cut low, 53.4 bushels; and uncut, 46.7 bushels per acre. The cutting back delayed the ripening period of the oats from 4 to 12 days. This is a factor which must be taken into consideration in the work of the farm.

Varieties—Practically all the oats cultivated in the world belong to the one species *Avena sativa*. There are 2 classes of these oats, those in which the panicle branches from either side of the stem, of which the Welcome is a good illustration; and those in which the head or panicle branches on only one side and which are ordinarily termed side-oats. The Seizure is a good representative of this class. Between oats with open, branching panicles and side-oats, there are all gradations. The different varieties also vary in color from white, black and red to intermediate colors. The weight of oats also varies in different localities from 25 pounds to 50 pounds per bushel. The usual legal weight in most of the States is 32 pounds per bushel. More than 150 varieties are in cultivation. In the States from Pennsylvania north and west the following varieties have oftenest given the heaviest yields at the agricultural experiment stations: Lincoln, American Banner, Pringle Progress, White Bonanza, Belgian, New Zealand, Monarch, Early Archangel, Wideawake, Improved American, Welcome, Clydesdale and Early Dakota. In the more southern States the varieties Virginia Gray (Fig. 70), Red Rust Proof, Gray Winter, Beardless and Prince Edward Island have given the best yields. A hulless variety of oats (*A. nuda*) is sometimes grown in this country. The grain weighs about 50 pounds per bushel, but it does not yield as well per acre as the other sorts.

Feeding Value—The oat grain is richer in digestible protein than either corn or wheat, while the oil content is about the same as in corn. The starchy material is proportionately low. The grain, therefore, constitutes in itself quite a well-balanced ration and is considered preeminently suited for horses. It is also one of the best grains for breeding sheep and hogs, also for growing young stock. The lightest oats contain the largest proportion of grain to hull, and are, therefore, pound for pound, richer in feeding value than heavy oats. For horses the grain should be fed unground. Bran and shorts fed to work horses and mules at the North Dakota Station proved equal to oats in feeding value. Oats when fed to lambs conduce to their growth rather than fattening. For the latter purpose, therefore, they are not as good as corn. The Michigan Station found that it required about a fourth more oats to produce a given gain in lambs than with corn. It is probable, however, that in general feeding these figures will be found a little high. As a food for milch cows, at the Wisconsin Station, ground oats gave 10 per cent better results as regards milk and butter fat than an equal amount of wheat bran. For feeding to pigs oats should be ground. For fattening hogs the best results will be obtained if it is fed with corn meal in the proportion of 1-3 oat meal and 2-3 corn meal. (See also *Horses, Sheep, Cows* and under *Dairy Farming* for feeding experiments with oats.)

Enemies: SMUTS (*Ustilago avenae* and *U. levis*) are by far the most important diseases of oats. Loose smut is perhaps the most common species of smut and is found wherever oats are grown. The smut ripens when the grain is in the flower and is blown away by the wind, leaving the heads bare. The other form of smut is not observed until the hull is removed, when the kernel is found to be replaced by smut. The disease is carried by the seed and all treatment is applied to the seed.

Seed oats may be soaked for 2 hours in a solution of formalin containing 1 pound to 50 or 60 gallons of water. This treatment is simple and very effective in preventing smut. The same method may be used for the stinking smut of wheat. Good results will also be obtained by soaking seed oats for 24 hours in a solution of potassium sulphide (liver of sulphur), containing 1½ pounds to 225 gallons of water. In applying either of these methods care should be exercised that all the grain is thoroughly wetted by the solution. The bags which hold the grain should preferably be of coarse material so as to allow the rapid penetration of the water.

The hot water treatment may be adopted for stinking smut of wheat or oat smut. For practicing this method two large vessels should be provided, one containing water at a temperature of 110° to 120° F., and the other hot water at 132° to 133° F. The seed oats are warmed up in the first vessel, and are then placed in the second vessel for 10 minutes, when they are taken out to dry. The temperature of the water in the second vessel should be watched carefully and should be kept at 132° or 133° F., not allowing it to go below 130° or above 135° F. The volume of water should be from 6 to 10 times greater than that of the seed. Any of these 3 treatments is effective if carefully applied.

In treating wheat for loose smut the grain should be soaked in cold water for from 4 to 8 hours and then be subjected to hot water for 5 minutes at a temperature of 132° F. In treating barley seed for smuts the same preliminary soaking should be given and the seed subjected to hot water at 130° F. for 5 minutes. The stinking smut of wheat may be prevented by soaking the seed for 10 minutes in water at 132° F.

After treatment seed grain should be spread out on a clean floor or canvas to dry. The floor or canvas and the bags in which the grain is placed after drying should be free from smut. Seed grain may easily be reinfected by coming in contact with smutty bags or seeders.

Oat smut may also be prevented by thoroughly sprinkling seed oats with a solution of blue vitriol containing 1 pound to 10 gallons of water. For this purpose the seed should be placed in a heap on a floor and shoveled over to insure wetting of all the grain. Wheat seed may be treated in the same manner, but with a somewhat stronger solution of blue vitriol (1 pound to 5-10 gallons of water). Chemical treatment for corn smut is of no avail. (See under *Corn.*) Rye smut may be largely prevented by treating the seed in water at 127° for 5 minutes.

Rust (See under *Wheat*)—Oats are occasionally attacked by bacterial blight, leafspot and mildew, but these diseases are not of much importance. (Ill. Expt. Sta. Bul. 57; U. S. Dept. Agr. Farmers' Bul. 75; Ohio Expt. Sta. Bul. 97.)

For insect enemies see under *Wheat.*

PEANUT (*Arachis hypogaea*)

Also called Earthnut, Ground pea, Goober, etc. A trailing leguminous plant 1 to 2 feet high, which blossoms along the stems, and after the flowers fall pushes the ovaries into the ground and matures the pods there as seen in Fig. 71. Peanuts will grow practically anywhere that Indian corn matures; but the crop is most extensively grown in the States of Virginia, Georgia, North Carolina and Tennessee. It requires about 5 months to mature and is sensitive to frost. The yearly production of the United States is about 4 million bushels of 22 pounds each.

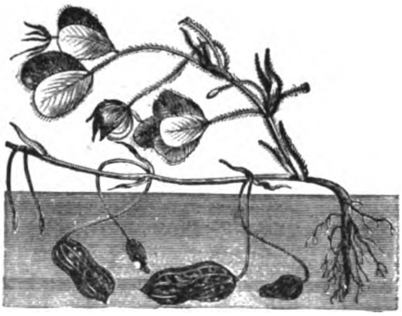

Fig. 71—PORTION OF PEANUT PLANT

Soils—A sandy loam soil best suits the peanut. On heavy soils the pods cannot push their way into the ground to mature. Dark or red soils discolor the pods and greatly injure their market value. Gray colored soils that are porous and not too rich are usually advised. The peanut, being a legume, draws a portion of the nitrogen required in its growth from the air. (See *Leguminous Plants.*) Potash and phosphoric acid are therefore the most essential fertilizer elements to apply. In Maryland and Virginia and other localities in the South where lime is lacking in much of the soil this element must also be added. Soils very rich in vegetable matter produce vines rather than fruit, and the quality of the nuts is inferior.

Planting—Land for peanuts requires early plowing and thorough cultivation and pulverizing. Planting should be done about the time or immediately after corn planting. The seed is planted either in hills or drills and the distances apart depend on the variety grown and the richness of the soil. Generally the rows are made 24 to 36 inches apart each way and 2 seed planted at each intersection. The seed should be hulled and care taken not to break the inner husk. They should be covered about 2 inches deep. At the Arkansas Station considerably heavier yields were obtained when the rows were 2 feet apart than when they were 3 feet apart, and in other experiments at the same station nuts planted in pods broken once in two at time of planting made as good a stand as shelled nuts. This result indicates that much of the expense of shelling peanuts by hand for planting can be saved. During the growing season the crop will require frequent shallow cultivation. The old method of ridging to cover the bloom of the plant has been found unnecessary, and, indeed, much better yields are obtained by level culture. The vines should not be disturbed after they begin to bloom.

Harvesting—If the crop is grown for hogs they may be turned into the field about the time of the first frost. If grown for market and hay the harvesting should take place just before frost comes. The harvesting is done by running a special kind of plow along the rows, which cuts the tap root and loosens the peanuts. The vines are then thrown in windrows, and if cut in the morning are stacked or shocked in the afternoon in piles about 7 feet high, placing a pole in the center if necessary. The vines should be so placed that most of the pods are on the inside of the pile. They should also be kept off the ground by a few poles and covered with hay or cornstalks to keep out the rain.

When the vines have dried 15 to 20 days the pods may be picked. Women and children usually do this by hand. After picking the pods should be cleaned by revolving in a cheap slat drum to remove any adhering soil and to polish the hulls. Cleaned peanuts are sacked in 100-pound sacks and sent to market. The average yield of peanuts in the United States is about 18 bushels per acre. This is very low. On fair land and with some attention to culture 30 to 60 bushels should be obtained, and 100 bushels per acre is not infrequent.

Varieties—The most prominent American variety and commercial peanut is the Virginia running variety. This has large, spreading vines and bears large white pods weighing 22 pounds to the bushel. Virginia Bunch, as its name suggests, is of more compact growth and the fruit is borne near the tap root. The pods closely resemble those of the running variety. The Tennessee white variety closely resembles the Virginia running variety. An earlier red variety is also cultivated. The Spanish variety is grown almost entirely for forage. It is a small upright vine producing pods near the tap root. It should be planted much closer together than other varieties. It yields heavily per acre and is an especially desirable variety to grow for hogs.

Uses—Peanuts in this country are used almost entirely for eating out of hand and in confectionery. Inferior grades are used to fatten hogs. In Europe, and to some extent in this country, immense quantities of peanuts are crushed for oil, which resembles olive oil, and is used for many of the same purposes. The residue forms a prominent cattle food. The vines are used for hay and are fed to all animals. In composition it closely resembles clover hay. The Spanish variety is probably the best to grow for hogs. The hogs do their own harvesting. For feeding experiments with peanuts see under *Pigs*. The plant is also of value as a green manure; cowpeas, however, are better and will grow on poorer land.

The peanut is sometimes attacked by leaf spot and anthracnose, which may be checked with Bordeaux mixture. (See also U. S. Dept. Agr. Farmers' Bul. 25 on Peanuts: Culture and Uses.)

POPCORN (*Zea mays* var.)

This is a small growing, small eared kind of corn, the kernel of which possesses the property of popping or turning inside out upon the application of heat. The popped corn is tender and eaten out of hand or made up in confectionery. There are 2 well-recognized types of popcorn, viz., popcorn with rounded kernels resembling flint corn, but smaller (Fig. 72), and rice popcorn, with pointed kernels. (Fig. 73.) In all there are about 25 varieties of popcorn, the more popular of which are Golden, Pearl and Rice.

Popcorn will readily cross with field corn and sweet corn, and should therefore not be planted near these. It is cultivated like sweet corn. (See *Sweet Corn.*) After harvesting it should be stored in some dry loft for a season or two. Dry 2-year-old corn pops best.

For the insects and diseases affecting popcorn see under *Corn.*

POTATO (*Solanum tuberosum*)

The potato is a native of America, and, next to the cereals, is probably the most important food plant grown for man. The annual crop in the United States is about 200,000,000 bushels, and there are several countries in Europe where the crop greatly exceeds this amount. The most important potato growing States are New York, Iowa, Pennsylvania, Michigan, Illinois, Ohio, Wisconsin, Nebraska, Minnesota, Missouri, Kansas and Maine. New York leads. The potato grows best in a moist, cool climate. It does well in all the Southern States and succeeds north into Canada and Alaska. The average yield per acre for the whole country is a little less than

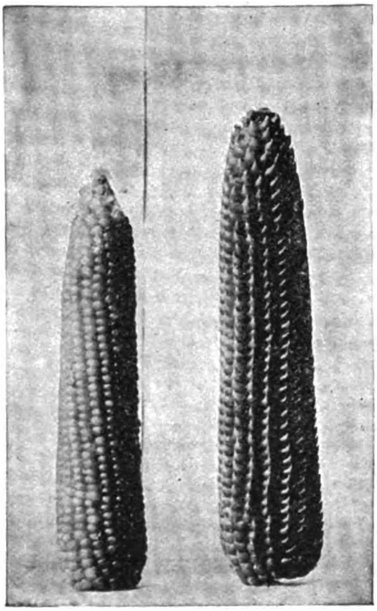

Fig. 72 SILVER LACE POPCORN   Fig. 73 WHITE RICE POPCORN

100 bushels. Yields of 250 to 300 bushels per acre are common. Two hundred bushels per acre may be considered a good yield. The average price per bushel ranges between 35 and 45 cents.

Soil—The heaviest yields of potatoes, and potatoes of the best qualities, are grown on rich, sandy loams which are well supplied with organic matter and naturally well drained. The crop is grown, however, and very successfully, on nearly all kinds of soil. On heavy clays the tubers tend to sogginess. All stiff soils should be lightened by drainage and by plowing under green crops and barnyard manure. Newly cleared forest land is especially desirable for potatoes. It is of prime importance that the soil be not only fertile, but in a good mechanical condition, loose, friable, deep and mellow. The crop does especially well on heavy clover sod or after a good crop of cowpeas. Owing to the scab and other potato diseases a clean crop cannot be successfully grown on the same ground year after year, thus making rotation with other crops essential. A successful 3 years' rotation in many large potato districts consists of fall wheat seeded to clover in the spring the first year; clover, the second season, plowed under in fall or winter; and potatoes the third year.

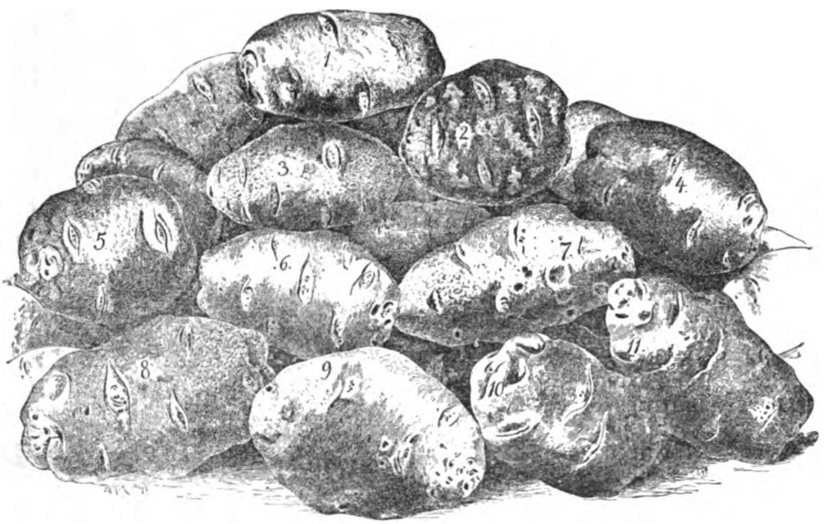

Fig. 74—POPULAR VARIETIES OF POTATOES

1 Early Rose
2 Manhattan
3 Early Vermont
4 Rural New Yorker No. 2
5 Garnet Chili
6 Polaris
7 Empire State
8 Dakota Red
9 Barclay's Prolific
10 Bell
11 New Minister

Next to a fertile soil thorough preparation before planting is one of the most important factors in successful potato growing. Heavy soils should be plowed in the fall and exposed to the action of winter frosts. The plowing should be deep and cultivation frequent, and at the time of planting the soil should be mellow and loose. The roots of the potato feed deep, though the tubers are generally formed within 6 inches of the surface.

Manuring—Except on rich garden soils or soils abundantly supplied with humus, the best fertilizer for potatoes is well-rotted barnyard manure. When applied directly to the potato crop the tubers are likely to be scabby. It is therefore usually applied to the preceding crop, but in such abundance as to leave the land well prepared for potatoes. Potatoes do well after a heavily manured corn, clover or grass crop. On soils that have been made rich in humus by the application of barnyard manure or the plowing under of green crops commercial fertilizers will be found of most value. Generally the use of a complete fertilizer will give the best results. A complete fertilizer is one that contains nitrogen, phosphoric acid and potash. Nitrate of soda is one of the best sources of nitrogen for potatoes. In many tests of potash fertilizers for potatoes the best quality of potatoes, *i. e.*, potatoes richest in starch, have been obtained by the use of sulphate of potash. Equally as heavy yields have been obtained when kainit, muriate of potash or unleached wood ashes have been used. The superphosphates are most valuable as sources of phosphoric acid. Thomas slag at the Ohio Station proved a better source of phosphoric acid for potatoes than either dissolved boneblack or acid phosphate. There are many special potato fertilizers on the market. These generally contain relatively large amounts of potash. A potato fertilizer formula that is used by many large potato growers in the vicinity of New York city is made up as follows:

Nitrate of soda	127 lbs.
High grade dried blood	440 lbs.
Acid phosphate	1000 lbs.
Sulphate (or muriate) of potash	400 lbs.
Land plaster	33 lbs.
Total	2000 lbs.

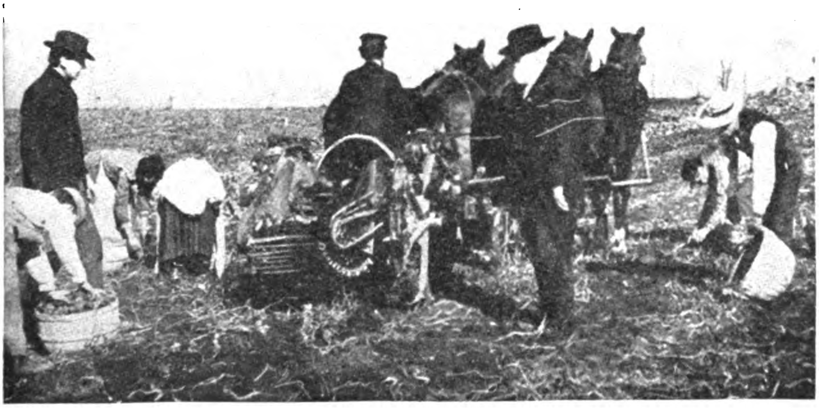

Fig. 75—DIGGING POTATOES BY MACHINERY IN MINNESOTA

At the New York Station the greatest profit resulted when these fertilizers were mixed and applied at the rate of 1000 pounds per acre. For potatoes in North Carolina, Massey recommends the following fertilizer formula:

Nitrate of soda	300 lbs.
Cottonseed meal or fish scrap	600 lbs.
Dissolved boneblack or acid phosphate	800 lbs.
Muriate of potash	300 lbs.
Total	2000 lbs.

From 1000 to 2000 pounds of this mixture should be applied per acre.

Fertilizers for potatoes should be applied when the ground is being prepared and thoroughly mixed into the soil. If nitrate of soda is used it should be withheld and applied along the rows after the potatoes are up. It does not make much difference whether the fertilizers are applied above or below the potatoes, but they should not be applied in immediate contact with the seed pieces.

Planting—Potatoes are planted at different times, depending on whether an early, late or mid-season crop is desired. The early crop is put in the ground as soon as settled weather comes. The plant is sensitive to frost, but the seed pieces start slowly and are not likely to get above ground until danger from frost is past. If they do and frost threatens they may be covered over with soil by running the cultivator alongside of them. The ground should have been cultivated 2 or 3 times to warm it up and make it mellow. The main or late crop of potatoes is planted some time later; in the North about the middle of May. and in the South a second crop is planted sometime in late July or in August.

The rows should be 3 feet wide to admit of horse cultivation, the furrows 4 inches deep and the seed pieces placed 16 to 18 inches distant in the furrow. The rows may be made with a plow or horse hoe, and the seed pieces dropped by hand and covered either with the plow or by hand with a hoe. There are a number of excellent potato planters now on the market.

Seed for Planting—An enormous number of experiments have been made relative to the seed used in growing a crop of potatoes. By "seed" is meant potato tubers. The seed produced in the seedballs on the potato stalks above ground is of no value in growing a commercial crop of potatoes. It will grow, however, if planted and produce inferior tubers, and is of value in originating new sorts. The best seed potatoes generally are those grown in the locality where they are to be planted. As between those grown farther north and those farther south those from the more northern locality should be chosen.

In the South second crop potatoes are better than first crop or Northern potatoes for seed. Unsprouted tubers are better than cellar-sprouted tubers. When tubers are stored in a damp cellar or pit they are liable to send out long white sprouts, which must be rubbed off at planting time. The growth of these sprouts weakens the tubers. If, however, the tubers are spread out in a shallow layer in a bright, sunny room the sprouts that start are short and sturdy and will start off and grow more rapidly and thus produce an earlier crop than tubers that have not sprouted at all or that have grown long, weak sprouts in the dark.

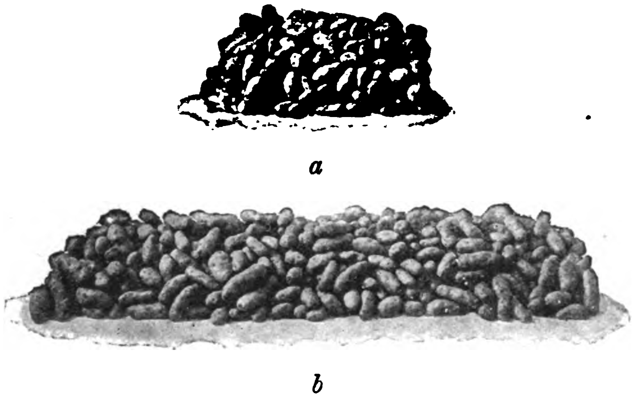

Fig. 76—*a*, YIELD OF UNSPRAYED POTATO PLOT; *b*, OF SPRAYED PLOT

Tubers should not be cut for seed more than a few days before they are planted. Small potatoes may be used for planting when the price of potatoes is high; but generally medium sized potatoes will give the best results. All parts of the tuber are equally valuable for planting and it has been shown by innumerable experiments that in ordinary farm practice an increase in seed from 1 eye up to the whole potato produces an increase in the total yield; but the increase from the use of the whole potato over the half potato is not sufficient to pay for the greater amount of seed required. A good rule to observe is, that when seed is high, plant quarters; when it is cheap, use halves. With small potatoes never use anything less than halves.

Cultivation—After the crop is planted, but before the plants have broken through the soil, run over the field with a light harrow or weeder. This will break up the crust and kill the weeds that are just starting. Harrow the field again about a week or 10 days later and again when the plants are 3 or 4 inches high. This harrowing, especially if the teeth are slanted backward, will not harm the young potato plants, but will keep the weeds down and practically do away with the necessity for any hand work in cultivating the crop. Thereafter cultivation between the rows should be shallow and frequent throughout the growing period, keeping the ground level. A little soil should be thrown toward the plants about the time they begin to blossom or just before, but hilling is inadvisable if the seed has been planted 4 inches deep. The vines will need spraying for the blight and beetles at different periods during the season, directions for which are given under *Enemies* on Page 92. The effect of spraying on the yield of potatoes is shown in Fig. 76.

Mulching—The mulching of potatoes with straw, hay or leaves is not generally to be recommended. In experiments at 3 stations considerably better yields were obtained by cultivation than by mulching. (See *Mulch.*)

Harvesting—The early crop of potatoes may be dug and harvested just as soon as the tubers have reached marketable size. With the main crop, however, the potatoes should be left undisturbed until the vines are dead and the tubers well ripened. If the tubers are immature the skin is tender and easily rubbed off in handling, to the detriment of their appearance and marketableness. If the tubers are rotting in the early fall they should be dug at once, assorted and stored; but if they are keeping well it is not advisable to dig them until as late in the fall as possible. The crop may be dug by hand with a 4-tined fork or a potato hook, but in large fields the expense will be lessened by using some one of the many potato diggers now found on the market. They do the work fully as well as when done by hand and are much more rapid and economical. A scene of digging potatoes by machinery on a Minnesota farm is presented in Fig. 75.

Potatoes are kept over winter either in a cool, dark cellar or in pits made in the field. Bins in the cellar should have slatted bottoms and not be more than 5 feet deep. In the field a good size for pits is 4 feet wide, 4 feet deep and about 6 feet long. The pit should be filled heaping up and a 6-inch layer of straw or hay spread over the pile and a little earth. The pile may be left thus for the potatoes to sweat and cool off until the approach of cold weather, when it should be covered about 18 inches deep with earth and 2 feet deep with barnyard manure or straw. Potatoes are greatly injured by freezing, being made unpalatable and unmarketable.

Composition and Use—The chief constituent of potatoes is starch. The starch content varies with the variety of potato grown, soil upon which it is grown, etc., from 12 to 20 per cent, and averages about 18 per cent. From 76 to 78 per cent is water. (See *Appendix.*)

Potatoes are used in this country primarily as a vegetable food for man. In the industries they are used in the production of starch and alcohol. Small and unsalable potatoes are used for stock feeding. (See *Sheep, Cattle, Pigs.*) For cattle and sheep they should be sliced, and for hogs cooked. As a feeding stuff potatoes are about equal to beets and turnips, but the cost of growing them is too high to compete with these larger roots.

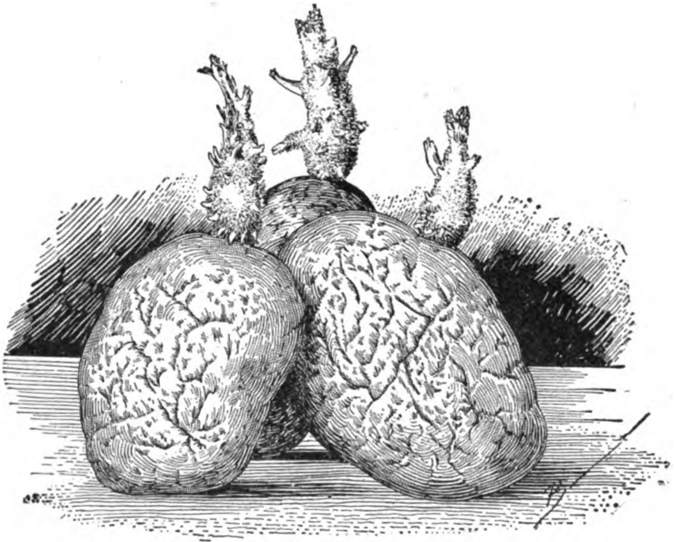

Fig. 77—SPROUTED TUBERS FOR EARLY CROP

Varieties—As with other farm crops, there are many varieties of potatoes. The markets usually prefer an oval, smooth, white or pink potato. The following are among the more widely cultivated sorts: *Early,* Early Ohio, Early Rose, Beauty of Hebron and Triumph. *Medium and late,* Burbank, Rural New Yorker No. 2, Empire State, Mammoth Pearl, White Star and Dakota Red. Fig.

74 shows a number of popular varieties of potatoes.

Second Crop Potatoes—In a number of the Southern States 2 crops of potatoes are grown each season. The first crop is usually grown as described above. The second crop is grown from the small potatoes produced by the first crop. The small seed potatoes should be exposed for several days in a light, shady place until they become greenish and then covered with a light layer of straw or pine needles and earth until they have sprouted. In planting use only the tubers that have sprouted. Whole seed is best. Plant in a furrow 6 inches deep and cover an inch deep at first and gradually fill in the trench by subsequent cultivation. The advantage of the second crop is their superiority in winter keeping qualities. It is very difficult to keep the first crop over winter without sprouting and rotting; but the second crop can be kept perfectly. The second crop potatoes are very popular for seed and believed to be superior to Northern seed for the first crop southern potatoes.

Extra Early Potatoes—Extra early crops of potatoes are obtained by using early varieties, planting early in the season in warm, rich soil having a southern exposure, using an abundance of commercial fertilizers containing quickly available plant food, fall plowing, and planting tubers that have been sprouted by exposure in a fairly warm light room. If sprouted in the dark the sprouts will be long, white, weak and worthless. But if sprouted in light the sprouts are short (½ to 3 inches long), sturdy and vigorous and will start off promptly when placed in the ground. (See Fig. 77.) The Rhode Island Station made a rack with shelves 8 inches apart for sprouting seed potatoes which proved very efficient. Some growers allow the seed potatoes for the early crop to lie on the ground exposed to the sun for a few days after digging or until they become greenish. They are then stored in shallow bins in a light room over winter. Care must be observed in handling the seed thus sprouted not to break the sprouts and to plant them right side up. If frost threatens the early crop the plow or cultivator may be used alongside of them to cover them over.

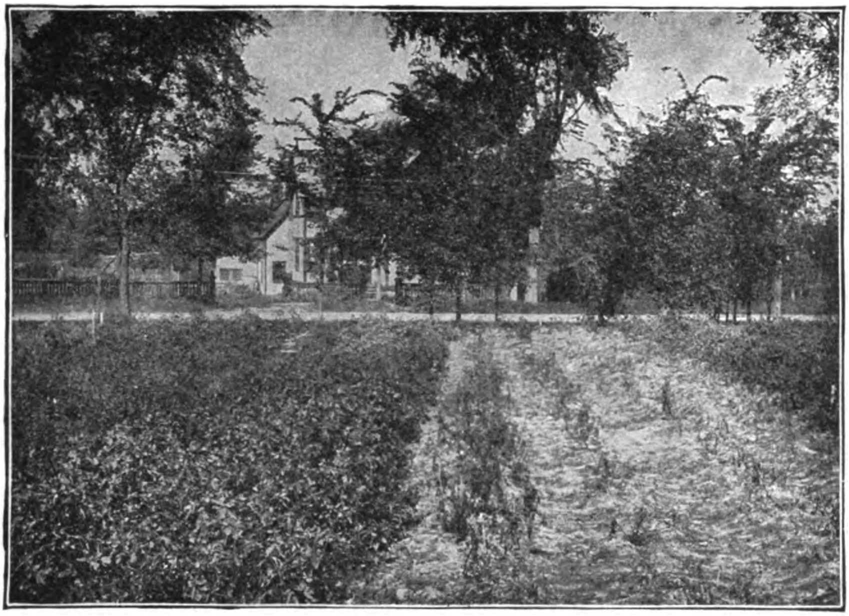
Fig. 78—SPRAYED AND UNSPRAYED POTATOES

Some of the more valuable bulletins on potatoes are as follows: U. S. Dept. Agr. Farmers' Bul. 35; Mich. Expt. Sta. Buls. 93 and 119; N. Y. Cornell Expt. Sta. Buls. 130, 140, 156, 191 and 196; Pa. State Dept. Agr. Bul. 105.

Enemies: DOWNY MILDEW OR ROT (*Phytophthora infestans*) attacks stems, leaves and tubers. On the leaves black or brown spots suddenly appear and the blight spreads rapidly over the fields. The diseased areas become soft and give out a disagreeable odor. Sunken dark spots appear on the tubers. The under side of affected spots on the leaves is covered with a white coating. The disease appears between the middle of July and the first of September. Decayed tubers should not be used for seed. Rot is easily controlled by making several applications of Bordeaux mixture to potato vines, beginning when the plants are 4 to 6 inches high and repeating 4 or 5 times at intervals of 2 weeks. A field of sprayed and one of unsprayed potatoes are seen in Fig. 78.

Leaf Blight or Early Blight (*Alternaria solani*) appears in June and July and attacks the leaves and stems. Small gray-brown spots appear on the leaves and soon become dry and crisp, as seen in Fig. 79. The spots are more numerous on the edges of the leaves and often occur at points injured by flea beetles. The disease progresses slowly, the leaves finally turning brown and curling up. Treatment should be the same as for downy mildew.

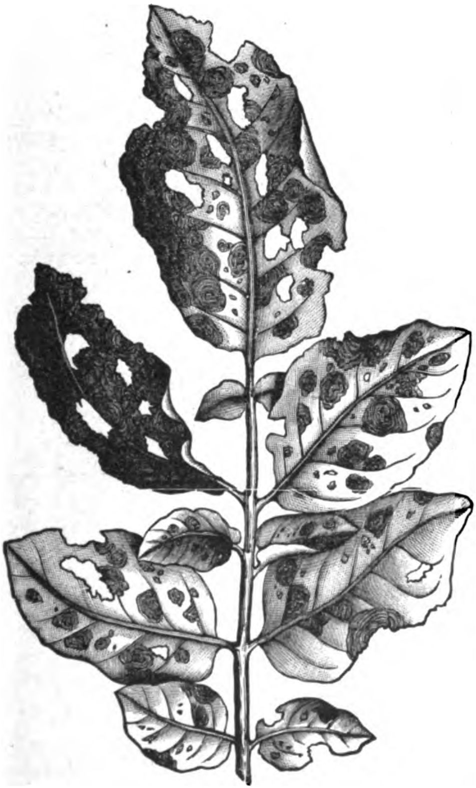

Fig. 79—POTATO EARLY BLIGHT

Brown Rot (*Bacillus solanacearum*) is especially injurious in the Southern States and attacks also eggplant and tomato. All parts of potato plants are affected. The plants wilt, turn brown and decay. The tubers sometimes exhibit brown patches before underging soft rot, as seen in Fig. 80. Rotation of crops, destruction of diseased tubers, and the treatment described for downy mildew are recommended.

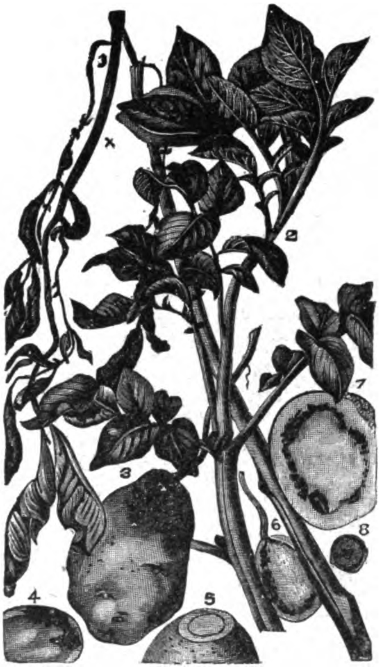

Fig. 80—POTATO BROWN ROT

Scab (*Oospora scabies*) attacks potatoes and beets. It first appears as slight swellings on the surface of the tubers. The elevations are often highly colored and increase in size until the skin bursts. The scab areas may remain elevated above the surface of the tubers, or by the gradual decomposition of the tissue they may become sunken pits of greater or less depth. Some varieties are much more resistant to scab than others. The presence of large quantities of stable manure or alkaline fertilizers may favor the development of scab. On badly infested soil, rotation of crops should be followed. Seed potatoes should be treated by soaking for 2 hours in a solution containing ½ pint commercial formalin to 15 gallons water, or soaking for 1½ hours in a solution containing 1 ounce of corrosive sublimate in 7 gallons of water. The formalin treatment is to be preferred. Seed potatoes may be inclosed in tight boxes and treated with formaldehyde gas. Putting sulphur in the hills at planting time is of little avail. A tuber badly affected with scab is seen in Fig. 81.

Stem Rot (*Rhizoctonia solani*) occurs on potatoes quite generally throughout the country but has been reported as unusually serious in Colorado. Affected plants die early in the season or large stems are developed with few or no tubers. The fungus passes the winter in the form of dark patches on the tubers. Rotation of crops is recommended for badly infected fields. Seed potatoes should be treated before planting, treatment being the same as for scab.

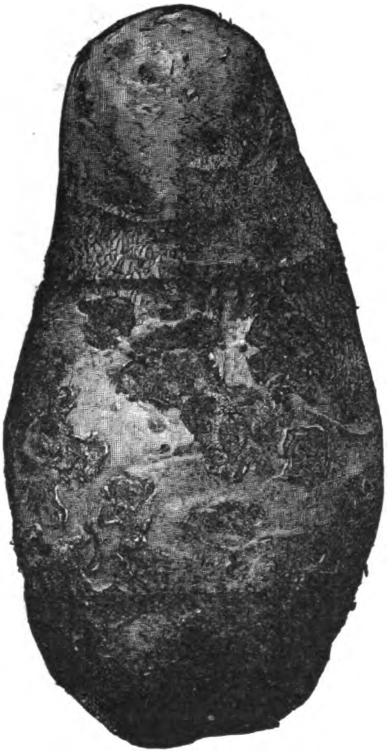

Fig. 81—POTATO AFFECTED WITH SCAB

Potatoes are also attacked by dry rot, stem blight, wilt and other diseases, but they are seldom of great importance.

Colorado Potato Beetle (*Doryphora decemlineata*) first attracted attention in 1859 and has since spread over the greater portion of the country. There are usually 3 broods per year, the adults of the last brood passing the winter in the soil or under rubbish. The female lays her eggs in small yellow clusters on the leaves of potato and other plants of the nightshade family. Eggs hatch in about a week and the larvae become full grown in about 15 days. The insect feeds on potatoes in both the adult and the larval conditions, as seen in Fig. 82.

The red or orange colored slugs and the striped beetles are too familiar to require description. Potato plants may be dusted with Paris green or London purple mixed with flour or plaster, or may be sprayed with these poisons in the proportion of 1 ounce to 6 or 8 gallons of water. In small potato patches hand picking and gathering eggs will be found advantageous. Recent extensive experiments in Maine indicate that arsenate of lead is perhaps the most effective remedy to be used against this beetle. For preparation see *Insecticides*.

Stalk Weevil (*Trichobaris trinotata*) is a beetle of an ash gray color, 1-5 of an inch long, marked with 3 black spots on the wing covers. The grub when full grown has a brown head and bears a few light colored hairs. This insect infests ground cherry, horse nettle and other weeds. The eggs are laid about the first of June and there is only 1 brood per year. The adult passes the winter inside of the plant. The weevil may be captured by sweeping the vines with an insect net or may be destroyed by spraying with arsenate of lead or Paris green. Potato vines should be destroyed as soon as the potatoes are dug.

Potato Worm (*Gelechia operculella*) is a gray-brown moth 1-3 inch in length and measuring 2-3 inch across the extended wings. This insect is injurious to tobacco in the Southern States and is the most serious insect pest of potatoes on the Pacific coast. The injury to potatoes is done both in the field and after storing. The larva bores through the stems of plants in the field, and in the substance of the tuber either in the field or in storehouses. A practical method for controlling this insect consists in destroying the potato tops in the field shortly before digging and before the larva has penetrated into the tuber. In this way the larvae are destroyed and the species is prevented from multiplying indefinitely in storehouses.

Blister Beetles—This family of insects includes a number of beetles of medium or large size, with a soft body, broad head abruptly constricted into a neck, and with comparatively soft wing covers. The common name is given them on account of the irritating secretion which is emitted when the beetles are roughly handled and which may cause a blister upon the skin. There are many species of these beetles which are commonly found on the foliage and flowers of different plants, from which they feed in the adult stage. They are especially common on goldenrod in the fall. Several species feed on potatoes, tomatoes, asters, chrysanthemums, beets and other cultivated plants. The so-called "old-fashioned" potato beetle, which was well known before the advent of the Colorado potato beetle, belongs to this family. The different species are variously colored, but may be recognized after a little experience from their similarity in form and texture. The blister beetles commonly travel in swarms and may cause great injury to cultivated plants before they are observed. They may be destroyed by poisoning with arsenical applications or by knocking them off infested plants into vessels containing water covered with a film of kerosene. Some of the commonest species may be driven out of aster beds or beet fields by brushing with a wisp of straw or cloth. The larvae of blister beetles are to some extent beneficial, on account of their habit of eating grasshopper eggs. These beetles are almost always abundant where grasshoppers, especially the Rocky Mountain locust, occur. At times it is difficult to control them by arsenical sprays, since they may leave the plants immediately after spraying and thus avoid being poisoned.

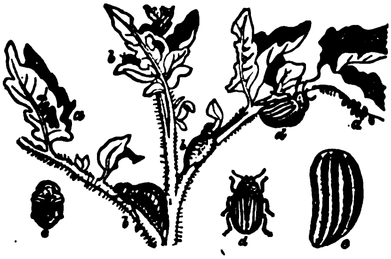

Fig. 82—COLORADO POTATO BEETLE

a a, eggs; *b b*, larvae; *c*, pupa; *d d*, beetles; *e*, wing of beetle enlarged

Tortoise Beetle—See under *Sweet Potato.*

The potato is also attacked by flea beetles, white grubs (Fig. 83), wireworms (see *Index* for these subjects), and many other insects of less importance.

PRICKLY COMFREY (*Symphytum asperrimum*)

A rank growing, succulent forage plant. It is of value principally as a soiling crop. The plant grows to a hight of 3 or 4 feet and has large, long leaves which are mucilaginous in character. It is very hardy, growing north into Michigan and Canada and affording 3 to 5 cuttings per season. A yield of over 30 tons per acre is reported from the Wisconsin Station and a grower in New York reports a total yield of over 50 tons per acre. These are exceptional yields, however. A yield of 10 to 15 tons reported from the North Carolina Station is more nearly the average.

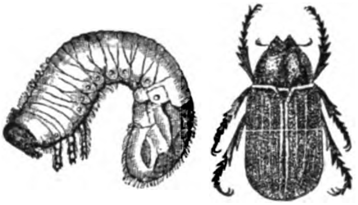

Fig. 83—WHITE GRUB, LARVA AND BEETLE

The plant will grow on light lands of inferior fertility, but gives the best yields on rich soils heavily fertilized. It is grown from roots set in the spring. These are fleshy like dock roots and go down deep into the soil. They should be planted in rows 3½ feet apart and 18 inches distant in the row and kept well cultivated. A large yield of forage can be obtained the first year; but the heaviest yields are not obtained until the second or third year. In gathering the crop for forage it may be safely cut as close to the ground as a grass knife will run.

One of the chief objections to this plant is the difficulty experienced in getting stock to eat it. Cattle learn to like it in time, but can scarcely be induced to touch it at first. A little bran or salt sprinkled on the leaves at the first few feedings will make it more palatable. Prickly comfrey, though boomed a few years ago as a wonderful forage plant, is scarcely grown anywhere in the United States. In Europe it is quite widely grown for soiling. Where good crops of corn, clover and other soiling plants can be grown the plant will find but limited use. In composition, prickly comfrey compares favorably with other succulent forage crops, but has nothing special to recommend it. It is of no use for hay.

RAMIE (*Boehmeria nivea*)

Also called China grass. This is a fiber plant and belongs to the same family as hemp. It has long been grown in the East and used in the tedious hand manufacture of fine grades of textiles. It is also used for cordage and other coarse manufactures. It has been successfully grown in some of the Gulf States and parts of California, but it is not likely to become an established industry of importance until some more successful machine has been devised for extracting the fiber. A flowering spike of ramie is seen in Fig. 84.

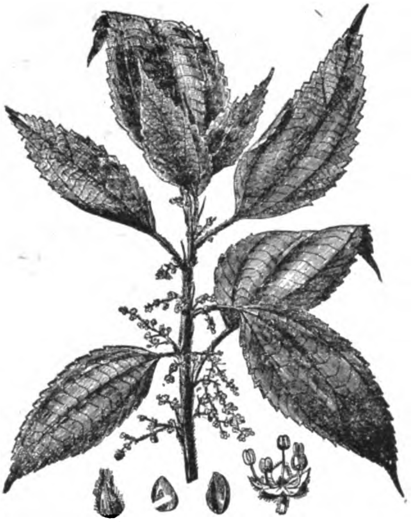

Fig. 84—RAMIE

Ramie is a semi-tropical plant, growing 4 to 8 feet high. The fiber is formed in the bark. The plant grows rapidly, producing 2 to 4 annual crops without replanting, and 1 planting endures for several seasons. It is propagated by seed, roots and by layering. The usual method of propagation in this country is by roots. These are cut 4 to 6 inches long and contain several eyes. They are set in ridged rows 4 to 4½ feet apart and placed in the ground about 1 foot apart. If plants are grown from seed they must be started in hotbeds. Light sandy alluvial soils which are fertile and hold moisture well throughout the season are recommended. The land should be plowed at least a foot deep and thoroughly harrowed.

RAPE (*Brassica napus*)

This plant is grown in this country and Canada principally as a forage for sheep, hogs and dairy cows. It is fed or pastured green and seldom if ever made into hay or put into the silo. An annual kind is grown extensively in Europe and to a limited extent in this country for the seed, which is used in the production of oil and for feeding to cage birds. This kind is of little value as a forage plant. The rape which has recently become so prominent in the Northern States as a forage crop is a biennial plant almost identical in appearance during its early stages of growth with the rutabaga plant, except that the root does not develop into a bulb. The top grows from 18 inches to 4 feet high and produces an abundance of tender succulent leaves greatly relished by stock. A field of Dwarf Essex rape is seen in Fig. 85 and a single plant in Fig. 86.

Practically the only varieties of rape in cultivation for forage and of value for this purpose are Dwarf Essex and Dwarf Victoria Rape. Rape, like other plants of the cabbage family, grows best in the rather cool, moist weather of spring and fall. It seems especially well suited to the Northern States bordering on Canada but may be grown in the South to advantage during the late fall, winter and early spring.

Soils—Rape grows best in soils rich in humus and vegetable matter. It is especially luxuriant on well worked muck or old pasture lands. The soil cannot be made too rich for it. On lighter soils it is apt to be dwarfed in growth and disappointing. Rich clay loams give good results. The ground should be put in fine tilth. If a crop is grown for cutting and feeding green in summer the ground should be fall-plowed, then worked down in the spring as early as possible with a disc or spring tooth harrow and pulverizer.

Planting—For the early crop rape should be seeded as early in spring as the ground can be worked. If the crop is grown for fall pasturing the Michigan Station considers July 1 as about the right time to sow the main crop in that state. The crop matures for feeding in about 2 months from the time of seeding. The seed is sown either broadcast at the rate of 3 pounds per acre or in drills 30 inches apart at the rate of 2 pounds per acre. A number of experiments at the stations indicate that better results are secured by the latter method. The seed should be covered with a light harrow when broadcasted. If seeded in drills a common garden drill will answer satisfactorily on a small scale. Rape is sometimes seeded between the rows of corn at the last cultivation, but is not so satisfactory as seeding alone. The crop is also seeded in the spring with fall sown rye or spring oats, the rape coming on after these crops are harvested. At the Iowa Station rape seeded in the oat field 10 days after the oats were sown yielded at the rate of 18 tons of green forage per acre. For convenience in harvesting the oats it is recommended that the rape be sown 2 or 3 weeks after the oats are sown. When rape is seeded in rows it should be cultivated 3 or 4 times before the first cutting is made, and immediately after each subsequent cutting it should again be cultivated.

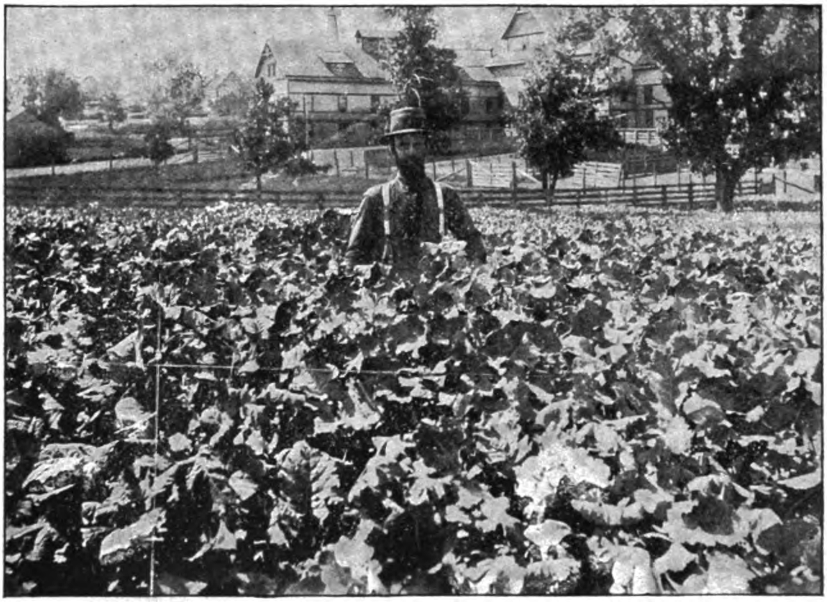

Fig. 85—FIELD OF DWARF ESSEX RAPE
(Wis. Expt. Sta.)

Using the Crop—The Canadian Experiment Stations have used rape as a green succulent food for dairy cows with good results. No taint in the milk occurred when the rape was fed in moderate quantities immediately after milking. The Wisconsin Station found rape an excellent crop to cut and feed green to breeding ewes and lambs in July when the pastures were failing. When rape is sown early in the spring and used for feeding green, 3 cuttings can be secured in an average season. Experiments in Wisconsin indicate that the best results are obtained by cutting the plants 4 inches from the ground. The stumps readily sprout and produce succeeding crops. On good soil a yield of 30 tons of green forage per acre may be expected. The crop should be cut when it has reached its maximum growth. If allowed to stand after this it looses its succulence and palatability and becomes woody.

Hogs greatly relish rape. At the Wisconsin Station it was found that an acre of rape would pasture 20 hogs with the grain they received 3 months. Hogs pastured on rape ate much less grain than those not thus pastured and made fully as rapid gains. It was found that an acre of rape was equivalent in feeding value for hogs to 2767 pounds of grain (corn and shorts). For late summer and fall pasturing of hogs rape is a very desirable crop.

Rape has been found especially valuable as fall pasturage for lambs that are being fattened. (See *Sheep.*) Better results are secured if the fields are so arranged that the lambs can also have access to grass pasture while feeding on the rape. An acre of rape will furnish about 2 months' pasture for 20 lambs which are being fed some grain in addition. Stated in another way, an acre of rape will produce about 400 pounds of mutton. The sheep should be observed closely when first turned onto the rape, as bloating may occur. This phase of rape feeding, together with the value of rape for sheep, is discussed in some detail under *Sheep*. (See *Sheep*.) (See also Wis. Expt. Sta. Bul. 58; Mich. Expt. Sta. Bul. 114; U. S. Dept. Agr. Farmers' Bul. 164.)

For enemies see under *Cabbage*.

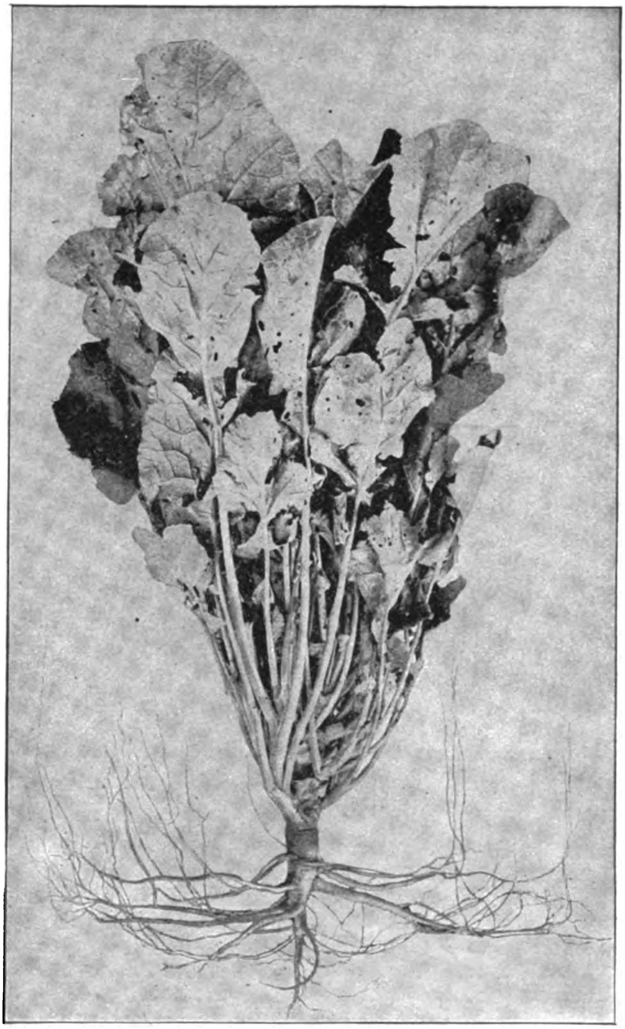

Fig. 86—PLANT OF DWARF ESSEX RAPE

RICE (*Oryza sativa*)

This grain constitutes the chief food of half the people of the earth. It is most grown and used in China, Japan and India. Its commercial production in the United States is limited to the South Atlantic and Gulf States. South Carolina and Georgia formerly led in its production, but now over 90 per cent of the crop is grown in Louisiana and Texas. The United States rice crop in 1902 amounted to a little more than 331 million pounds. The discovery of artesian well water underlying large tracts of level, alluvial lands in Louisiana and

Texas and the application of farm machinery have resulted in a rapid development of the rice growing industry within these states during the past 10 years.

Commercial rice growing is practically limited to ground that can be irrigated, though there are some varieties adapted to upland culture. These latter are of so little importance in the United States as not to permit of discussion here. Another essential of successful rice growing is a moist climate. The best soil for rice is a medium loam containing about 50 per cent of clay. Alluvial lands along Southern rivers and the rich drift soils of Louisiana and Texas prairies have proved especially well adapted to rice culture. A subsoil of clay is practically essential. This retains water and permits of rapid drainage at harvest time so that machinery can be used.

In delta lands, coast marshes and river bottoms the fields are so arranged by a series of canals and embankments as to permit of flooding and drainage at any time. The usual method of preparing the land is by thorough plowing, disking, harrowing and rolling in the spring. Shallow plowing is usual. In a portion of Southern Louisiana the rice land is so low, wet and stiff that it is plowed under water.

Seed is sown from March 15 to the middle of May. Seeding should occur soon after the spring plowing and in most cases the seed should be in the ground by April 20. The amount sown varies from 1 to 3 bushels per acre. It is advisable to sow with a seeder after the ground has been rolled, though the usual custom is to broadcast. After the seed is sown in some sections enough water is let on to saturate the ground for the purpose of germinating the seed. If there is sufficient moisture already in the soil this irrigation is omitted. This latter practice is uncertain and irrigation is recommended. In South Carolina the land is put in fine tilth just before seeding. Rows 12 inches apart and 2 to 3 inches deep and at right angles to the drains are made and the seed dropped into these and lightly covered.

In general practice, when the rice is about 8 inches high it is flooded. The field should be covered evenly 3 to 6 inches deep and renewed by a continuous inflow and outflow. In South Carolina water is let on the rice as soon as the seed is sown and allowed to remain until the grain is well sprouted. It is then withdrawn. When the rice has made 2 leaves it is covered 10 to 12 inches deep and gradually reduced to 6 inches, where it is held 20 to 30 days. It is then withdrawn, and the crop weeded. No further water is then put on until jointing commences. It is then again flooded and kept so until about 8 days before harvesting, when the water is withdrawn for the ground to dry.

Rice is ready to cut when the straw first begins to turn yellow. Where the crop cannot be cut by machinery the sickle is generally employed. It is cut 5 to 6 inches from the ground and laid on the stubble to dry, after which it is bound in small bundles like wheat and shocked on dry ground. Stacking is of less importance than with wheat. A machine is now generally employed in threshing the same as for other cereals. The average yield of rice in South Atlantic states is about 32 bushels per acre and the cost of production $24. A rice harvesting scene in Louisiana is seen in Fig. 87.

One of the serious obstacles to rice growing is weeds, chief of which is red rice. This is a wild, hardy rice and its presence in the cleaned grain reduces the price. It is recommended that the rice field be plowed soon after harvesting, well cultivated and then seeded to oats or like crop as a means of suppressing it. No seed containing red rice should be planted.

The level prairie lands of Southeastern Texas and Southwestern Louisiana have been found especially well suited to commercial rice growing. The level lands make possible fields of 40 to 80 acres in extent, so that all modern machinery can be used in growing and harvesting the crop. Many pumping stations along streams have been built, artesian wells put in and hundreds of miles of canals built. The industry in this section of the country is steadily growing in extent each year.

Rice is principally used for human consumption. Rice meal, which is a by-product in the preparation of rice grain for the market, is of considerable value as a stock food. Rice hulls are of very low feeding value, but are of use as a mulch and fertilizer. The straw is used for about the same purposes as wheat straw. For a further account of rice growing see U. S. Dept. Agr. Div. Bot. Bul. 22, Office of Expt. Stations Bul. 113, and Farmers' Bul. 110, upon which this account is based.

Enemies: SMUT (*Tilletia corona*) attacks the grains, transforming them into masses of black powder. Affected kernels are sometimes not distinguishable externally from sound ones. If rice seed be thrown into water, the smutted grains will float and may be skimmed off. Treatment should be the same as for oat smut.

BLIGHT OR BLAST appears as a sudden or gradual dying of the plants. The cause of the disease is not known, but overirrigation seems to favor its development.

RICE WEEVIL, see *Granary Insects.*

ROTATION OF CROPS

This term refers to the order in which crops are made to follow each other in different years on the farm. With most crops and on most soils rotation is very desirable. If potatoes are made to follow potatoes year after year the ground soon becomes so infected with disease that only scabby tubers can be grown. If clover is made to follow clover the soil becomes "clover sick" and the crop fails. Land kept continually in cereals becomes foul with weeds. The strawberry field long kept in strawberries becomes filled with injurious insects. Besides, the roots of many plants feed only in the shallow surface soil, leaving stores of food deeper in the ground untouched. It is desirable that such crops be rotated with deeper feeding crops so that the whole food supply of the soil may be utilized. Some plants use only the food stored in the soil and thus tend to impoverish the land. Others like the legumes draw a portion of their food from the air and thus become in a measure soil enrichers. Again different crops draw unequally on the different food elements of the soil. A crop of beans or peas draws heavily on the potash and lime in the soil, while a crop of wheat requires relatively small amounts of lime and potash but large amounts of phosphoric acid. The same soil will therefore more easily produce a large crop of beans and a large crop of wheat following each other than 2 successive crops of wheat or 2 crops of beans.

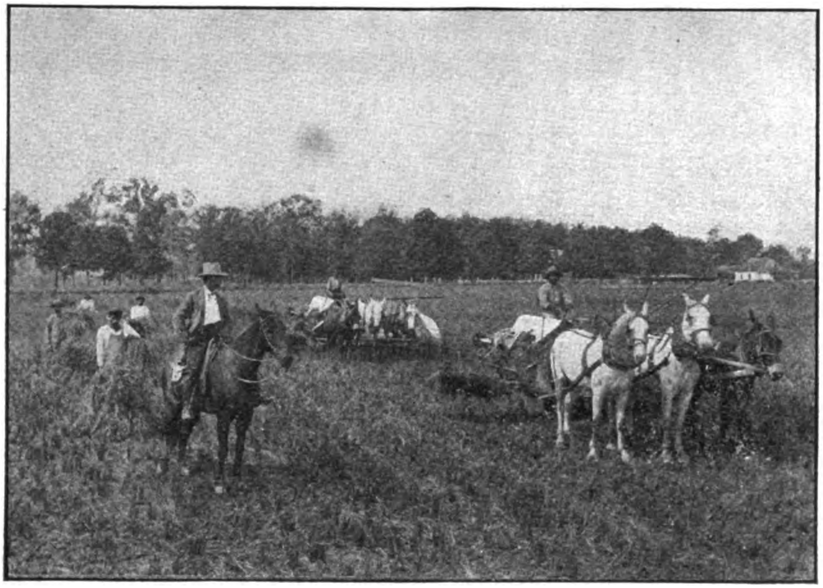

Fig. 87—HARVESTING RICE IN LOUISIANA

For all these reasons—the maintenance of soil fertility, the renovation of impoverished soils, the production of large crops, the destruction of insect and weed pests, and the more economical distribution of labor throughout the year and hence greater profits—a proper system of rotation is considered essential to continued success in modern farming.

Systems of crop rotation are generally designated by the number of crops entering into them. If 3 crops enter into the rotation it is known as a 3-course rotation; if 4 crops, a 4-course rotation, etc. One of the very successful rotations observed in some portions of Ohio is a 3-course rotation consisting of wheat, clover and potatoes. Wheat is grown the first year, clover the second, potatoes the third, and then wheat again and the rotation repeated. The rotation to be observed on different farms will necessarily vary with the nature of the soil, markets, etc., and so no one system can be given which will serve as a guide for all farms.

In general, a rotation should be so planned as to secure about the same amount of forage to feed each year and of grain and stock to sell. On light, sandy soils the English have found that a 4-course rotation of barley, clover, wheat and roots is especially valuable for their conditions. In this rotation the wheat stubble is thoroughly manured with well-rotted barnyard manure of the farm and plowed under in the spring in time to plant root crops (rutabagas and turnips). The root crops are kept well cultivated during the summer and the weeds kept down, thus making this the cleaning crop in the rotation. In the winter sheep are folded on the roots, and the plant food which the roots have gathered from various sources will be accumulated on the surface in the droppings of the sheep for the use of the barley crop which follows in the spring. Clover is seeded with the barley. The barley is a comparatively shallow feeding crop, while clover roots go deep into the soil. During the coming fall and winter the growing clover will prevent any losses from the soil by leaching. The clover is also a nitrogen gatherer (see *Leguminous Plants*) and fits the soil well for wheat, which follows. After the clover is cut for hay sheep are pastured on the aftermath until it is time to plow for wheat. This system of rotation is known as the "Norfolk system," after the county in England that first widely adopted it. It meets the requirements of light soils very perfectly and a modification of it may be found satisfactory in some localities in this country. Corn may be grown instead of turnips, oats instead of barley and rye instead of wheat. The land might also be kept longer in clover, especially if other grasses are seeded with it.

Systematic rotation is not as common in this country as it should be. The rich, seemingly inexhaustible soils of many of the Western States are not quick to show the need of rotation. Where rotation is practiced a 3-crop system is more common than a 4-crop system. Wheat 1 year followed by clover and grass 2 years, then corn with the manure made on the farm applied to the corn crop is common. A good 4-course rotation for the Northern States consists of wheat or rye followed by clover and grass, then corn with the manure of the farm applied to the corn crop. Oats follow the corn. The corn should be kept thoroughly cultivated to kill the weeds that start and at the last cultivation rye should be sown between the rows to furnish late fall and early spring pasture. The rye is turned under early in the spring. Oats follow the rye. When the oats are harvested the ground is immediately prepared for wheat. Timothy is seeded with wheat in the fall and clover in the spring. Corn follows the clover crop, and the rotation repeated. This is not an ideal rotation, but gives very good results.

The Rhode Island Station has greatly improved light and impoverished land by the following rotation: (1) 3-course, potatoes, winter rye, clover; (2) 4-course, corn, potatoes, rye, clover; and (3) 5-course rotation, corn, potatoes, rye, grass and clover for 2 years. Commercial fertilizers also were used. At the Delaware Station a good rotation for poor soil in bad condition was sweet corn followed by crimson clover the first year, cowpeas followed by winter oats the second year, and clover the third year.

For the South the Louisiana Station recommends the following rotation: Corn first year, oats followed by cowpeas the second and cotton the third year. Suitable rotations for dairy farms are noted under *Soiling*. In many Western and some Eastern States summer fallowing is practiced at stated intervals. This is for the purpose of giving the land a rest and freeing it from weeds. No crop is grown and the ground is kept cultivated during the season. Experiments repeatedly made have shown that this is not an economic practice. No return whatever is obtained from the use of the land for a whole season and if rains prevail much of the plant food of the soil is leached out. Land is rested when it is given a change of crop. It is better to grow some cultivated crop like corn or roots and seed down in the latter part of the season to some cover crop like rye, hairy vetch, etc. The cultivation during the early part of the season will kill the weeds and the cover crop smother any that remain, besides holding the soluble plant foods for the use of succeeding crops.

Some of the general principles that should guide in laying out a systematic rotation are as follows: (1) Have at least 1 leguminous crop in the rotation. (2) Have at least 1 cultivated crop. (3) Rotate shallow rooting crops with deep rooting crops. (4) In the South and on leachy soils plan to have a growing crop on the land all the time. (5) Avoid bare summer fallowing. (6) Do not rotate small cereals with other small cereals. (7) Plan the rotation so as to have about the same amount of forage each year. (8) Keep stock on the farm. (9) Unless it be thoroughly rotted apply the barnyard manure thus made to the rank growing crop in the rotation like corn.

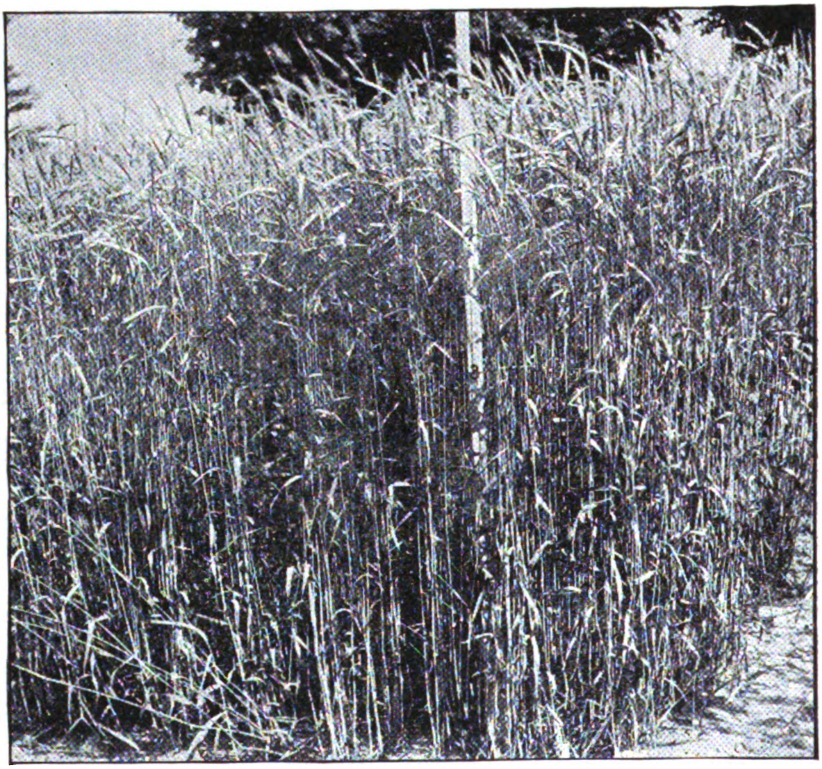

Fig. 88—TWENTIETH CENTURY WINTER RYE
(Tenn. Expt. Sta.)

RYE (*Secale cereale*)

Rye is grown in this country chiefly for forage and bread. The grain is also used for malting and the straw finds extensive use in paper making. The yield of grain averages for the United States about 15 bushels per acre. From 25 to 30 bushels per acre is considered a good yield on the better soils. The chief virtue of rye for forage is its hardiness, rapid growth early in the season before other crops come on, and its palatability to stock. Rye will also grow on poorer soils than any other cereal, and is hardier and will withstand a more rigorous climate even than wheat. Sown in the South in summer as a soiling crop it will give an abundance of forage at 3 to 4 cuttings during the fall and winter. Sown in cornfields in the North at the last cultivation it furnishes good late fall and early spring pasturage and can then be turned under for green manuring. It is frequently grown for the latter purpose alone.

Soil—The best quality of rye grain for bread is grown on a rather dry, sandy soil of medium fertility. A fair crop of rye can be secured on soil too poor to produce wheat or corn and with less care. It will not thrive on wet soils and heavy clays are not favorable to its best growth. The heaviest yield of grain and the greatest amount of forage are produced on the lighter fertile, well-drained loams.

Seeding, etc—The seedbed for rye is prepared in the same manner as for wheat. Rye is likewise seeded about the same time or just before wheat, no matter whether spring or winter varieties are used. Early seeding is especially desirable on poor soils, since with winter varieties of rye it gives the plants opportunity to become well rooted and tillered before severe weather sets in. When seeded on light soils the seedbed should be rolled after seeding except in the drier, windier sections of the West, where the ground should be left rough to retain snow. (See discussion under *Wheat* on this point.) Seeding with a drill gives better results on the average than broadcasting. The seed should be put in from 1 to 2½ inches deep, depending on the lightness and dryness of the soil. Where seeded early and on poor soils seeding at the rate of 3 to 4 pecks per acre is considered about right. On the better soils or when seeded late 1½ to 2 bushels is sown. Where the crop is grown for forage heavier seeding still is desirable, 3 or even 4 bushels per acre being used.

Rye sown in September at the Vermont Station gave an abundance of green forage for cows by the middle of May, After May the stalks became tough and unpalatable. The amount of rye forage will be considerably increased if it is grown after some leguminous crop like clover, cowpeas or soy beans. Seaweed proved an efficient fertilizer for rye at the Rhode Island Station. Well-rotted barnyard manure makes the best fertilizer for rye on sandy soils deficient in humus.

Harvesting and Varieties—Winter rye ripens before wheat. The grain is ready to cut when the straw changes color and the kernel passes into the hard dough stage. The crop is harvested and cared for in the same manner as wheat. Special machines are in use for threshing out the grain without mutilating the straw. This is of considerable advantage where the straw is used for packing or making into paper. Both winter and spring varieties of rye are grown. The winter varieties generally yield the heavier. No satisfactory tests of varieties have been reported by the experiment stations. A view of a field of Century rye is presented in Fig. 88.

Feeding Value—For the composition of rye see *Appendix.* Scarcely any experiments have been reported from the American experiment stations on the value of rye for feeding to stock. The composition of the grain is very similar to wheat. The matured straw has a very low feeding value. Foreign experiments show that when the grain is fed to milch cows it gives the butter an undesirable and sometimes bitter flavor. Fed to hogs it produces a good quality of pork and would seem to be about equal for this purpose to barley. Rye shorts fed alone appears to give a soft pork of poor quality. The South Dakota Station states that a field of winter rye pastured close in the spring by sheep then yielded 18 bushels to the acre. It has been grown in the neighborhood for 10 years without a single failure. Every

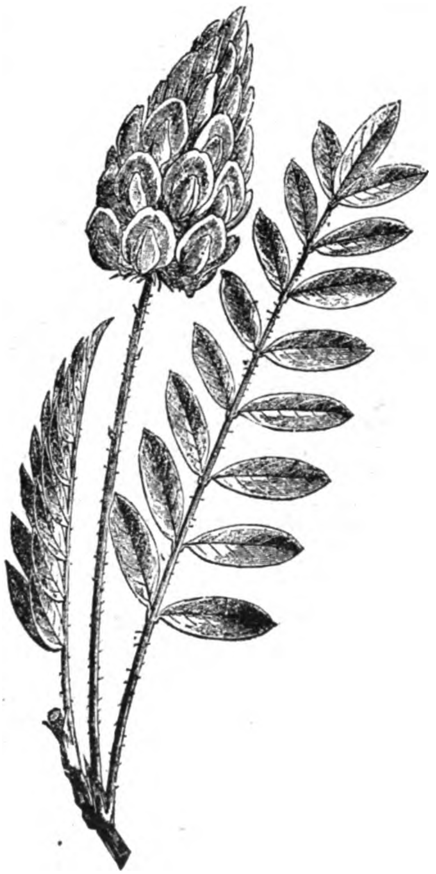

Fig. 89—SAINFOIN FOLIAGE AND FLOWER

farmer, the station states, may profitably grow it in that state for pasturage and grain combined.

Enemies: ERGOT (*Claviceps purpurea*) appears as a black, straight or curved spur, replacing the seed of rye and a number of grasses, especially blue joint and wild rye grass. The black spurs are longer than the seed of rye and grasses and may be readily recognized. The disease may be largely prevented by a proper rotation. For effect of ergot on stock see under *Poisonous Plants.*

RUST—See under *Wheat.*

SMUT—See under *Oats.*

INSECT ENEMIES—See under *Wheat.*

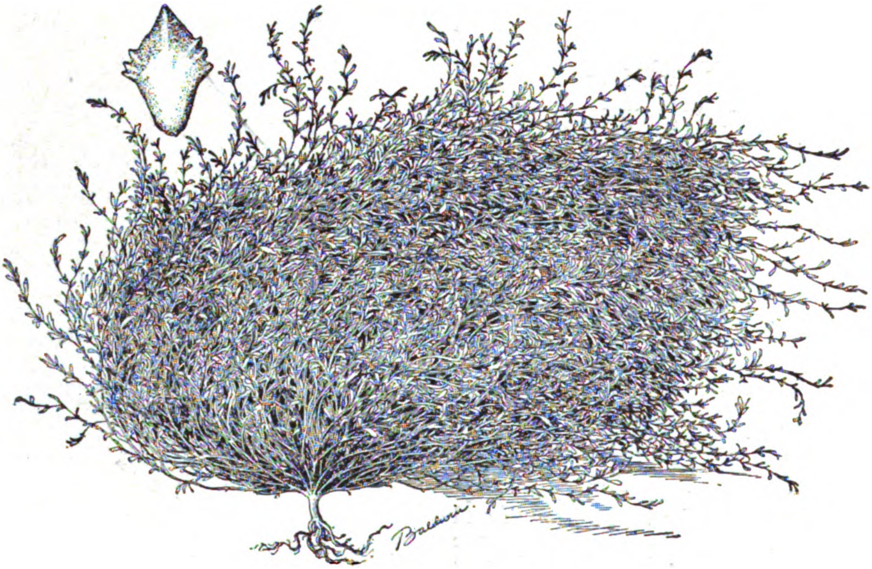

Fig. 90—AUSTRALIAN SALTBUSH
(U. S. Dept. Agr.)

SAINFOIN (*Onobrychis sativa*)

Also called Esparcet. A deep rooting, perennial, leguminous forage plant, 1 to 2 feet high, especially adapted for culture on ground too dry and barren for red clover or alfalfa. It has long been grown in Europe, but is little known here. The leaves are compound and composed of 6 to 12 pairs of leaflets, as shown in Fig. 89; flowers bright pink, in spike-like racemes. In Europe the yield of hay is from 1½ to 2½ tons per acre and is fully equal in feeding value to red clover.

Plant the seed any time from May 15 to June 30 in well-prepared land that is well underdrained. It is one of the best plants for barren hills. Cover a little deeper than alfalfa or clover seed. The plants are a little difficult to establish, but when well rooted will endure many years. About 80 pounds of fresh seed should be sown per acre. If this is shelled 40 pounds will be enough. One crop of hay may be cut annually. The yield of seed varies from 10 to 25 bushels of 40 pounds each annually. It will not stand close pasturing. The plant will grow anywhere in the United States, and its use on poor soils where clover will not grow is recommended.

For enemies see *Clover* and *Alfalfa.*

SALTBUSHES (*Atriplex* spp.)

Low, shrubby, much branched plants, especially valuable on some of the arid and alkaline soils of the West for forage. There are many native species of these plants. Many others have been introduced from Australia. The most generally useful species thus far cultivated agriculturally is *A. semibaccata,* introduced from Australia. This is a rapid growing perennial, thriving alike on soils containing as much as 1-3 of 1 per cent of alkali in the surface foot of soil and on arid non-alkaline hardpan uplands. At the California Station single plants sometimes reach a diameter of 12 feet. It is quite hardy, withstanding a temperature of at least 14° F. It has produced 5 tons of dry forage per acre on land where no other useful crop would grow and with a rainfall of less than 4 inches. The forage is eaten by all stock, though they sometimes do not relish it at first. Analyses show it to have nearly the same nutritive ratio as alfalfa. The California Station states as a result of 18 years' experience in growing saltbushes that this species "is unsurpassed among the gifts of nature to the deserts and the alkali wastes which cover so large a part of the earth's surface."

Saltbushes may be grown from cuttings, but are usually grown from seed. Station experiments in California indicate that on alkali soils the seed should be sown on top of the ground and well firmed in, but not covered. The best time for seeding in the warm districts in that state is early in October before the rains come. In experiments in seeding on non-alkaline, arid uplands the best results were secured when the seed was covered $\frac{1}{8}$ inch deep. When covered $\frac{1}{2}$ inch deep only 25 per cent of the seed sprouted. The seed may also be sprouted in boxes and transplanted in rows 4 feet apart on light or hardpan soils and 6 to 8 feet apart on alkali soils. The plants should stand from 1 to 4 feet apart in the rows. The young plants on being set out are treated like young cabbage plants.

For a further account of saltbushes see Cal. Expt. Sta. Bul. 125; U. S. Dept. Agr. Farmers' Bul. 108.

SAND LUCERNE (*Medicago media*)

This is so similar in appearance to alfalfa that it is difficult for the ordinary observer to distinguish them apart. It is a leguminous perennial forage plant and compares in feeding value favorably with alfalfa. Sand lucerne is a more spreading plant than alfalfa. The flowers vary in color from bluish to lemon yellow. The seed pods are in a $\frac{3}{4}$ coil rather than 2 coils, as is the case with alfalfa. It has been but little grown in the United States, but some recent experiments at the Michigan Station indicate that it has considerable value on light, sandy soils in situations where alfalfa winter-kills. Owing to the high price of sand lucerne seed, time required to establish the field, etc., it is recommended by that station only for permanent meadows. The crop was seeded at that station May 15 at the rate of about 20 pounds per acre. The lightest sandy soil on the farm was used. The following year it yielded at the rate of 6800 pounds cured hay per acre in 3 cuttings, the third year 10,580 pounds, fourth year 12,310 pounds, and fifth year 13,839 pounds in 4 cuttings, no manure being used in the meantime. All stock relished the hay and green forage. These figures show a high yield of forage for sand lucerne.

Seed broadcast on well prepared and finely pulverized soil at the rate of about 15 pounds per acre. Seed without a nurse crop. Keep the weeds in check by running over the field as often as necessary with a mower with the bar set high. Harvest as soon as the first blossoms appear. Seed at present is obtained from Europe and can be obtained through any reliable seed firm. Not enough experiments have yet been reported in this country to determine the value of sand lucerne as a forage plant. It appears to be well suited to sandy soils, and to withstand open winters better than alfalfa. (See also Mich. Expt. Sta. Bul. 198.)

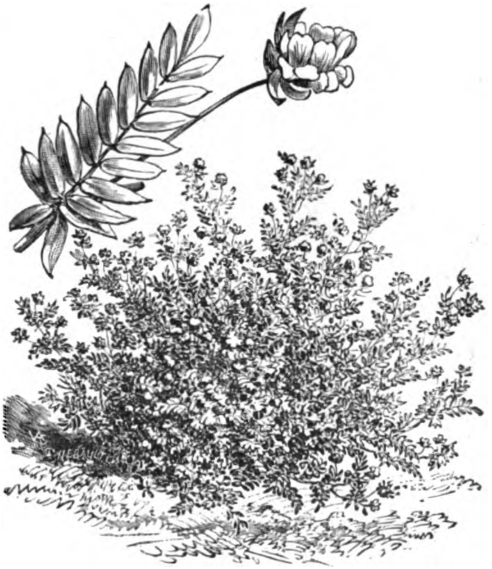
Fig. 91—SERRADELLA

SERRADELLA (*Ornithopus sativus*)

A slender leguminous annual, 12 to 18 inches high, slightly resembling vetch, as seen in Fig. 91. It is considerably grown in Europe as a green manure crop for dry, sandy soils, and to some extent for hay. It has been grown at a number of stations more or less successfully. In Massachusetts it yielded at the rate of 2 tons of hay per acre. At the Oregon Station it grew 40 inches high. Results obtained in feeding green serradella have been very satisfactory. In general it may be stated that where well-known forage crops can be successfully grown serradella has no place. Serradella may be seeded in the spring with any of the small cereals the same as clover is. When seeded alone it is best drilled in rows about 5 inches apart in March or April at the rate of 40 to 50 pounds of seed per acre. The seed matures by September.

SORGHUM (*Andropogon vulgare* var. *saccharatum*)

This plant resembles Indian corn in habit of growth and appearance, but is without ears. It is used in the production of molasses and sugar and as a forage plant. It was introduced from China in 1845 and now constitutes one of the staple crops of this country. A number of non-saccharine varieties of sorghum, as *Chicken Corn, Durra, Egyptian Rice Corn, Kafir Corn, Milo Maize* and *Broom Corn,* are discussed under their respective names in this work. Sorghum will grow wherever Indian corn will grow. It does better on poor soils and in drouthy regions than corn. For these reasons the culture of sorghum has assumed more importance in the West, South and Southwest than in the North and East. Good yields have also been obtained on alkali lands.

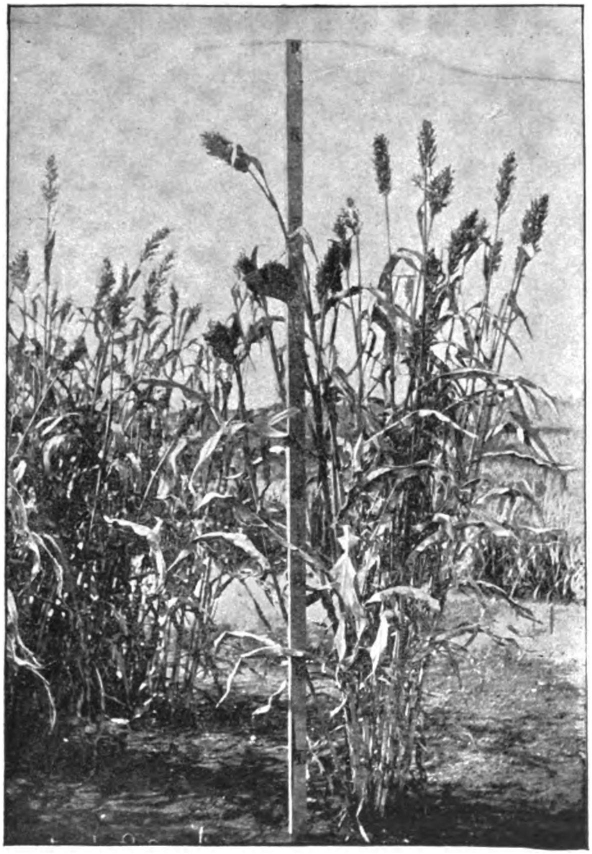

Fig. 92—EARLY AMBER SORGHUM

As a Sugar Plant—The production of sugar from sorghum has not yet assumed extended commercial importance, owing to the difficulty thus far experienced in securing profitable amounts of crystallizable sugar. No trouble is experienced in making a good quality of syrup and considerable amounts of sorghum are grown for this purpose. When sorghum is grown for syrup or sugar good corn or wheat lands are fitted as for corn. The seed may be sown either in hills or drills. On weedy land hill culture is advisable, since cultivation can then be practiced both ways. The hills should be about 3½ feet apart each way. From 20 to 25 seed should be dropped in each hill and covered 1 to 3 inches deep, depending on the dryness and lightness of the soil. When the plants get well up they should be thinned to 6 or 7 stalks in each hill. A large amount of seed is necessary, since some of it is likely to rot or fail to germinate.

If sown in drills the rows should be about 3½ feet apart and the plants 6 to 7 inches in the row. Sorghum should not be planted until after the ground gets thoroughly warmed up, generally not till the latter part of May or in June, after the corn is planted. It grows very slowly at first while it is making a root system, and weeds, if allowed to get a start, will quickly smother it. Frequent shallow cultivation should be given throughout the growing season and the suckers kept removed. The canes should be cut when the seed is in the hard dough stage. When grown for molasses the cane is stripped of its leaves and topped by hand. It should be cut and taken to the mill as soon as stripped. For this purpose it is usually tied in bundles about 8 inches in diameter. If these cannot be immediately worked up they should be piled in layers crosswise to admit of a free circulation of air. Frost injures the quality of the cane and the crop should be harvested before frosts come. At the sugar mills the cane is usually cut up into small pieces with the leaves on and the leaves afterward removed with a fanning mill.

The amount of sugar in sorghum varies from 10 to 20 per cent. The amount obtainable in commercial work has generally been considerably less than this. One of the best varieties is Early Amber. (Fig. 92.) Other excellent sorts are Minnesota Early Amber, Kansas Orange, Collier and Coleman. For methods of sorghum syrup manufacture see U. S. Dept. Agr. Farmers' Bul. 135.

As a Forage Plant—Sorghum is regarded as one of the most valuable forage crops. It is especially valuable for the drier portions of the South and for much of the semi-arid West and Southwest. Sorghum is a stronger feeding plant than corn and will do better on thin lands. Its roots feed deeper in the soil and the plant withstands drouth and alkali better. Seed broadcast or with a press drill after the soil becomes well warmed up at the rate of 1½ to 2 bushels per acre. Cultivate the seed in. A disc harrow has proved valuable for this purpose on dry, sandy soils. A better forage will be obtained if some plant like peas is seeded with the sorghum. In such cases 3 pecks to 1 bushel of each should be sown per acre. Good results are also obtained by seeding with a common seed drill. A partial view of a field of sorghum grown for fodder is presented in Fig. 93.

One difficulty in sorghum growing is the trouble from weeds. If the ground is weedy at the time of planting, the slow-starting sorghum is likely to be overtaken and smothered. In such cases cultivation with the harrow should begin while the weeds are small. The seedbed should be freshly harrowed just before the seed is sown in order to destroy all germinating weeds.

Sorghum grown for hay should be cut when the heads are well formed, and the seed about half ripened It may be cut with a mower, corn harvester, knife or binder, and shocked like corn. The usual method of cutting is with a mower. The sorghum is then left to lie on the ground a few days to dry out. If the crop is heavy it should be turned over so that the bottom part of the stalks is exposed to the sun. When well dried the sorghum is raked into good sized cocks. The crop may be fed directly from the cocks, or these may be allowed to stand a few days to undergo sweating and fermentation, then opened to the sun for a few hours and hauled to the barn or put in larger stacks. Sorghum does not keep long unless well cured and should be fed out during the fall and early winter.

Sorghum yields from 3 to 15 tons of cured forage per acre. When cut but once a yield of 5 to 10 tons may be expected on good soils. If 2 or more cuttings are obtained the yield sometimes runs up to 12 to 15 tons per acre. In general about a third heavier yield may be expected than with corn on the same soil.

Uses—Sorghum has a high value as a soiling crop. It is especially valuable for dairy cows and for fattening animals. It can be had in July, August and September, just when pastures are failing. Care should be observed to give the animals only a small amount at first until they grow accustomed to it. A light feed of grain or other food should be given first.

As a summer pasture sorghum is especially relished by sheep, cattle and hogs. For this purpose it should be sown or drilled thickly and several sowings made at different dates in order to secure a succession. It is the custom of many farmers to cut the first crop for hay and then pasture the field afterward with stock. Before cattle or sheep are turned on sorghum pasture they should be pastured on grass or given some dry feed and not turned into the field until the dew is off. Fatal results sometimes occur when cattle are allowed to eat freely of green sorghum. Under certain conditions prussic acid is formed in sorghum. (See *Kafir Corn,* page 75.) Experiments at the Nebraska Station indicate that the most pasturage on sorghum is obtained when the stalks have reached full hight, but before the heads have formed.

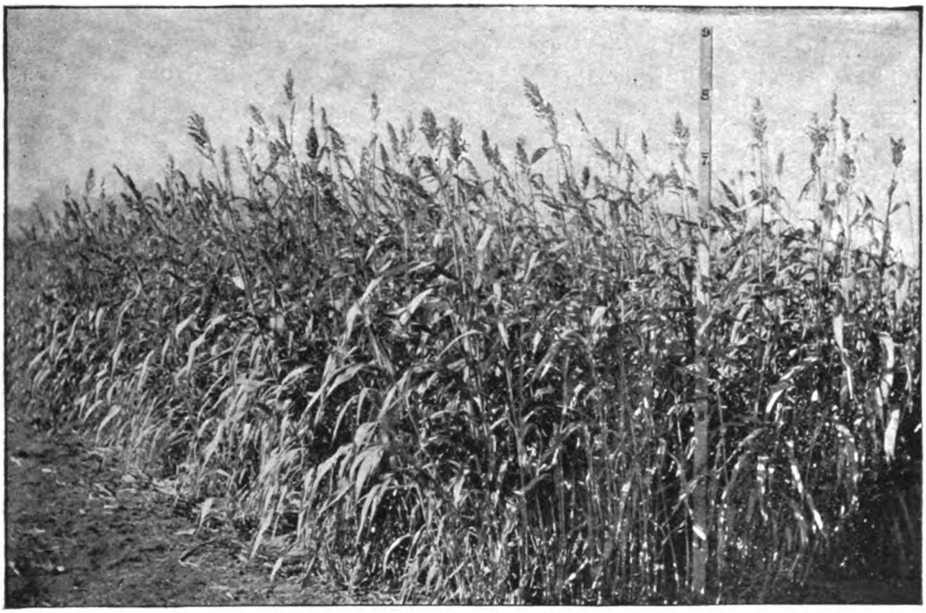

Fig. 93—SORGHUM GROWN FOR FODDER

Dry sorghum forage is fed like cornstalks in racks. It is more readily eaten by all stock than corn fodder, and there is much less waste in feeding it. Some sorghum silage has been made, but it is more difficult to keep in good condition than corn, and where corn can be obtained it is the better silage plant of the two.

Sorghum seed is somewhat similar in composition to corn, but is not so valuable for general feeding purposes. It is generally fed on the stalks with the forage. The seed should be ground. It is considered to be 90 per cent as valuable as corn. It is best to feed with wheat, bran, oats or peas. For composition see *Appendix.*

Varieties—The best sorghums for forage are the various Amber and Orange varieties. In the North and West, Early Amber and Minnesota Early Amber are extensively grown. The Orange varieties are somewhat later than the Ambers, and are more extensively grown in the South and Southwest.

For a further account of sorghum for forage see U. S. Dept. Agr. Farmers' Bul. 50, and Neb. Expt. Sta. Bul. 53.

Enemies: BLIGHT (*Bacillus sorghi*) appears on the leaves and leaf sheaths as red or brown spots. The disease spreads downward, the roots often being affected in a similar manner, and, if the plants are attacked while young, they may be killed outright. The discoloration is most marked on the inside of the sheaths. Some varieties of sorghum are quite resistant to the disease. The bacillus passes the winter in affected stalks, and the latter should, therefore, be destroyed by burning. Rotation of crops is also recommended.

SMUT of sorghum is of 2 kinds, grain smut and head smut. The first causes the formation of small smutted kernels and resembles in its effects the smuts of wheat and oats. The head smut affects the whole flower cluster, converting it into an irregular mass, which at first is inclosed in a white membrane. In its effects it more closely resembles corn smut. Grain smut of sorghum may be prevented by soaking the seed for 15 minutes in water at a temperature of 135° F. The head smut may be partly prevented by the treatment recommended for oat smut. (See under *Oats.*)

Sorghum is often attacked by corn aphis, grasshoppers and nematodes, but rarely in a serious manner.

SOY BEAN (*Glycine hispida*)

A leguminous plant grown in this country to a considerable extent during the past 15 years as a forage and seed plant. It is an erect annual, 1½ to 3½ feet high, with branching hairy stems and heavy foliage resembling in appearance that of the common field bean, but generally more hairy. The seed is of various colors, ranging from white to green and black, and rather small and spherical or elliptical in shape and compressed. It is a native of China and Japan and has been cultivated there for centuries as a human food. Here the bean is not relished as a table food. Of this plant the Kansas Station says: "We have found the soy bean to stand the drouth as well as the Kafir corn or sorghum, it is not touched by chinch bugs, the grain is a richer feed than linseed meal, and the plant enriches the soil on which it is grown."

The soy bean plant matures seed in 75 to 130 days from planting, depending on the variety; it is somewhat more resistant to frost than garden beans, and may be grown as far north as Indian corn. Experiments in semi-arid regions indicate that it resists drouth much better than corn. A soy bean plant and seed pods are shown in Fig. 94.

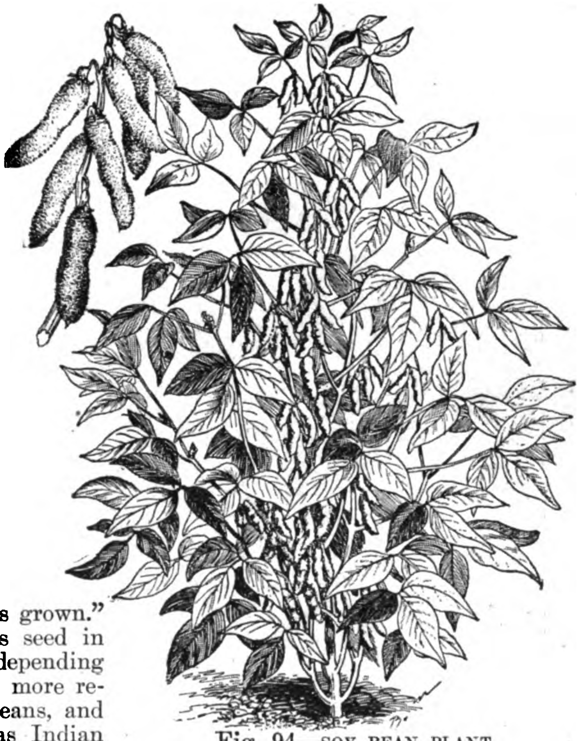

Fig. 94—SOY BEAN PLANT
(U. S. Dept. Agr.)

Soils and Fertilizers—The soy bean grows best on light, loamy soils, such as are best suited for corn. The soil should be prepared by plowing and working down fine with a harrow as for corn. Well-rotted barnyard manure mixed with a complete commercial fertilizer, has been found by the Connecticut Station to give better yields with this plant than commercial fertilizers alone.

Notwithstanding the fact that the soy bean is a legume, it still requires nitrogenous fertilizers such as barnyard manure for its best development, unless the soil upon which it grows contains the specific bacteria which form nodules on its roots. Most of the soils in this country have been found deficient in this organism. Under such conditions no tubercles are formed and the plant does not enrich the soil by adding nitrogen to it. (See *Leguminous Plants.*) Field experiments in Kansas and at other stations show that soils on which soy beans do not form root tubercles can be successfully inoculated by sowing in the drill with the beans 1000 to 1200 pounds per acre of dry soil taken from fields in which soy beans having root tubercles have been grown. A short row or two of beans can first be inoculated and the beans grown in this soil for a year or two, and this soil then used to inoculate the whole field. A field once inoculated probably remains so for many years. As a forage crop the soy bean will be found very valuable whether its growth adds nitrogen to the soil or not.*

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* The United States Department of Agriculture has recently offered to supply farmers, free of cost, a limited quantity of soy bean bacteria for inoculating new soils. A very rapid and efficient way of multiplying the bacteria has been found. Full directions for use accompany each package.

Planting and Cultivation—The soy bean is a warm weather plant and should not be sown until the soil becomes well warmed up in May or June. It is frequently sown after a rye or barley crop is taken off and a good growth of forage secured, or even of seed if early maturing varieties are grown. As a rule the beans should not be put in the ground until after corn is planted. The station experiments show that the best results are obtained with soy beans when they are seeded in rows 24 to 32 inches apart at the rate of ½ to ¾ bushel per acre, and level culture practiced. A common grain drill may be used for this purpose if some of the holes are stopped up to make the right spacing between the rows. The machine should drop 6 or 7 seed to each foot of row. The field should be cultivated shallow soon after the plants are up to keep down the weeds, and for a few times after rains to break up the crust that forms. Soy beans do not require as much cultivation as corn. As with field beans, cultivation should not be given when the plants are wet from rain or dew. A field of soy beans, as grown at the Minnesota Experiment Station, is seen in Fig. 95.

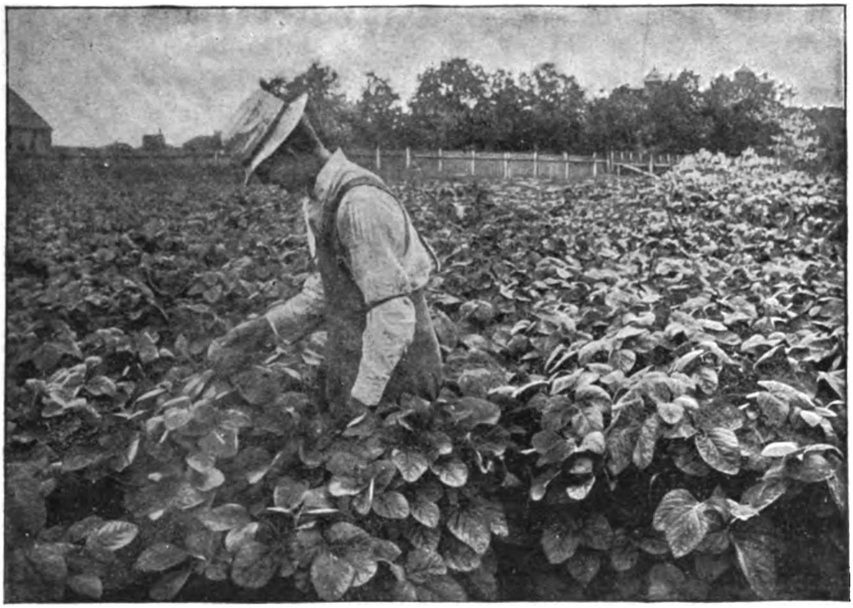


Fig. 95—FIELD OF SOY BEANS

Harvesting—Soy beans grown for soiling purposes may be cut from the time the plants come into bloom until the pods begin to ripen. For hay of the best quality the crop should be cut when in full bloom and the pods beginning to form. For silage it should be cut when the pods are well formed and the seed three-fourths grown. For seed the crop should be cut when the pods have turned brown, but before they are fully ripe; if too ripe the pods will burst open and scatter the seed.

The crop may be cut with a scythe, mower or regular bean harvester or pulled by hand. At the Kansas Station the crop was cut by removing the shovels from a double shovel cultivator and bolting on knives 18 inches long which set out from the cultivator and sloped back somewhat. With this arrangement 2 rows can be cut at once, the knives cutting off the plants just at the surface of the ground. When more than 10 acres are grown the Kansas Station recommends the use of a regular bean harvester. When the crop is grown for seed the plants are cut off, raked together in windrows and allowed to dry out a little, then stored or stacked in a dry place. For hay the crop in moist climates should be allowed to wilt and dry out some in the swath, and then put in small, loose piles to cure, and handled like clover hay.

The yield of green soy bean forage at the Connecticut Station on fairly good manured land was 10.3 tons per acre. This was about 1-3 less than corn on the same land. Yields of 15 tons per acre have been reported. At the Massachusetts Hatch Station yields of 25 to 40 bushels of dry beans per acre are reported. Yields of 15 to 20 bushels per acre are reported by the Connecticut Storrs Station, while the average yield at the Kansas Station under field conditions was 13 bushels per acre and the cost 40 to 50 cents per bushel for growing. Threshing is done with a common threshing machine by taking out the concaves, or by pounding out with a flail.

Uses—The dry beans are a highly nutritious feeding stuff and rank with linseed meal, gluten meal and cottonseed meal in feeding value for steers, dairy cows, calves, hogs and other stock. The meal has the same laxative effect as linseed meal, and when fed to dairy cows tends to soften the butter. At the Kansas Station 30 per cent better gains were made when soy bean meal constituted a part of the grain ration fed to hogs than when Kafir corn or corn meal was fed alone. The beans may be fed to hogs whole or ground or unthreshed on the stalks; if ground and fed with Kafir corn they should be mixed and wet just before feeding. Soy beans are too rich in protein (muscle and blood-making material) to be fed as the whole grain ration to animals. Better results will be obtained when it is fed with some more starchy grains that produce fat, like corn and Kafir corn. Three or 4 pounds of the meal added to the grain ration for dairy cows is advisable.

As a soiling crop for dairy cows soy beans have given excellent results from the standpoint of milk and butter production. They are especially valuable when mixed with such crops as corn and sorghum. The silage made from soy beans is very satisfactory. The late varieties yield heavily; the crop is easily ensiled, and the quality of the silage is even more satisfactory than soy bean hay and considerably more economical to make. The Connecticut Storrs Station recommends that the crop be ensiled with corn, putting the two down in alternate layers. This makes a more balanced ration than either alone. Soy beans are often pastured in the South with hogs, and the results have been very satisfactory. As a soil renovator soy beans rank close to red clover, but hardly equal that plant. For feeding experiments with soy beans see under each of the different farm animals, particularly swine. For composition see *Appendix*.

Varieties—There are a number of varieties of soy beans. Those in cultivation here are largely classified according to their period of ripening or the color of the seed. The leading varieties are Early White, Medium Early Green, Medium Black and Early Yellow. Early White is one of the best varieties to grow for seed. Medium Early Green is especially valuable for soiling and silage. The large late varieties are considered especially valuable for green manuring. At the Kansas Station Early Yellow is considered the variety best suited to the semi-arid conditions of that State.

For a further account of soy beans see Kan. Expt. Sta. Buls. Nos. 92, 96 and 100; Conn. Storrs Expt. Sta. Bul. 22; Mich. Expt. Sta. Bul. 199; U. S. Dept. Agr. Farmers' Bul. 58.

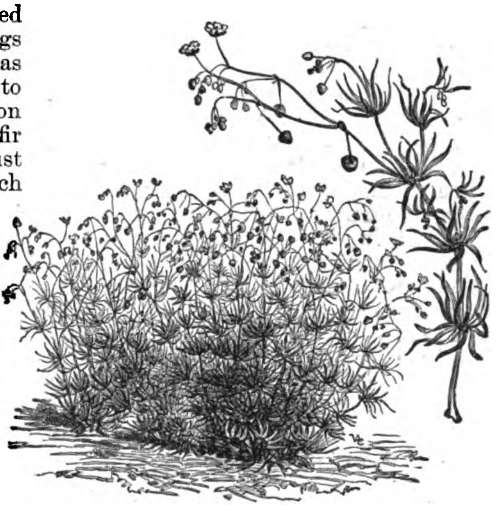


Fig. 96—SPURRY

SPURRY (*Spergula arvensis*)

An annual, 12 to 15 inches high, which produces a tangled mass of stems and numerous whorls of linear leaves. (Fig. 96.) It is valuable as a forage and green manure plant on light, sandy lands too poor to grow clover. On rich soils it is a weed and has no place in American agriculture. The Michigan Experiment Station found it valuable as a first crop on the sandy Jack pine plains of that State. In some parts of Germany, Holland, France and Belgium it is reported to be of great value on light and drifting sands. It stands drouth well.

Soil for spurry requires the same preparation as for clover. On poor lands it should be seeded alone at the rate of 6 to 8 quarts per acre and lightly harrowed in. The seed germinates quickly and ripens seed in about 8 weeks from time of sowing. It is ready to pasture in 4 to 6 weeks after sowing, and for hay about 6 weeks after. When grown for seed 4 quarts will be sufficient. If the crop is not cut till fall enough ripe seed will be scattered on the ground to reseed the crop. If the seed is harvested late in the fall enough seed will be scattered to reseed the crop the following spring if the ground is harrowed. The yield of spurry on the Jack pine plains in Michigan was at the rate of 8 to 12 bushels per acre. The plant makes a good pasture for all stock, especially sheep. Cattle at first refuse it, but eat it greedily when they become accustomed to it. (See also Mich. Expt. Sta. Bul. 91.)

SUGAR BEET

The sugar beet is a strain of our common garden beet that has been selected and improved with reference to its sugar content. Good varieties of these beets, grown under proper cultural conditions, now yield from 12 to 20 per cent of sugar. Two-thirds of the world's supply of sugar is obtained at the present time from the sugar beet. This sugar is identical in chemical composition and sweetening power with the sugar obtained from cane. The bulk of the beet sugar crop is produced in Europe; but within the past 10 years the industry has been rapidly developing within the United States, and now gives promise of becoming one of the most important agricultural industries in this country.

In this work the United States Department of Agriculture and the State Experiment Stations have taken a leading part. Vast quantities of beet seed have been distributed to farmers in all parts of the country, and hundreds of thousands of bulletins and pamphlets containing cultural directions and general information regarding sugar beets have been sent free to growers in every State. The beets grown have been analyzed, the cultural data obtained digested and the results published broadcast. As a result of all this work it has been definitely established that sugar beets can be successfully grown for sugar production in those portions of the United States which have a mean summer temperature of 70° F. These include portions of Connecticut, Massachusetts, Vermont, New York, New Jersey, Pennsylvania, Virginia, Maryland, Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, South Dakota, Nebraska, Colorado, New Mexico, Arizona, Utah, Idaho, Wyoming, Montana, Nevada, California, Oregon and Washington. Over 40 beet sugar factories are already established in 10 of these States, and during the season of 1902-03 218,405 tons of beet sugar was manufactured. About two-thirds of this amount was produced in equal portions in California and Michigan, while more than four-fifths of the remainder was manufactured in Nebraska, Utah, New York and Colorado. Sugar beet factories are also now in operation in Oregon, Washington, New Mexico, Illinois and Minnesota.

Factories—The manufacture of beet sugar cannot be done on a small scale by farmers, as is the case with sorghum and cane. "The juices of the beet are extracted with difficulty. They contain large quantities of mineral salts which render the crude sugar and molasses made therefrom bitter and unpalatable. The refining of the sugar is a process which requires an extensive outlay for machinery and a high degree of supervisory skill. It cannot, therefore, be accomplished upon the farm." The farmer is concerned primarily with the growing and marketing of the beets; the manufacture of the sugar is an industry entirely distinct from agriculture.

The cost of erecting a factory capable of using 300 tons of beets per day is about $250,000, and experience has shown that smaller factories are not profitable. The conditions affecting the establishment of a factory in any neighborhood after it has been determined by trials that sugar beets of good quality can be grown there are: (1) Suitable transportation facilities for both the raw beets and the refined sugar; (2) guaranty of the production of a sufficient quantity of beets for a good campaign; (3) abundant supply of pure water; (4) a daily supply of 50 tons of coal or its equivalent in wood and of 20 tons of lime rock; (5) competent labor at reasonable prices, and (6) economic methods of handling the pulp either by feeding to stock or preparing for market.

Further notes on the factory conditions of different States may be found in the United States Government special reports on sugar beets for 1897 to 1903; in "The American Sugar Industry," by Herbert Myrick, and in the publications of nearly all the experiment stations.

Soils—The work of the experiment stations has shown that the heaviest yields of sugar beets and beets containing the highest percentage of sugar in the juice are produced on rather heavy, well-drained and fertile clay loam soils. When possible loam soils should always be selected for sugar beets. On the lighter, sandier soils the beets will mature earlier, but the yield of both beets and sugar per acre will be less than on the heavier soils. Sugar beets on muck soils have generally given good yields, but the amount of sugar contained in the juice has been so low as to make their culture on such soils unprofitable. Hard clay soils should never be selected for sugar beets. On these soils the roots are unable to penetrate deeply and much of the beet grows above the ground. This portion has to be cut away in topping, occasioning a large loss in the yield of sugar. Heavy yields of sugar beets and beets of excellent quality have been grown on many of the alkali soils of the West. According to the Colorado Station sugar beets containing a high sugar content and percentage purity have been grown on soils showing a top incrustation of soluble salts ½ inch thick. Good beets have also been grown in alkali soils in California, New Mexico, Utah and Wyoming.

Preparing the Soil—A deep, mellow seedbed is esential to the production of shapely beets. The illustration (Fig. 97) shows the right position of the beet in the soil, and this is secured only when the soil has been deeply prepared and properly handled. Both European and American experiments show that on heavy lands the soil should be fall plowed 8 to 9 inches deep. A subsoil plow should follow in each furrow and loosen the soil 6 or 7 inches deeper. If the ground is plowed and subsoiled in the spring it should be done early so that capillarity may be restored before the dry weather of summer sets in. The following spring after the mellowing action of the winter's frost the soil should be thoroughly cultivated and harrowed and put in perfect tilth. At the Nebraska Station fall and spring prepared lands gave practically identical results. Generally, especially in the East, fall plowing is very desirable.

Fertilizers and Rotation—Sugar beets are about as exhaustive on the soil as other farm crops, but no more so. If the tops were left on the land and the pulp could be returned to it either directly or, better still, in the form of manure after it had been fed to animals, the crop would take away practically nothing from the soil, since the sugar in the juice contains no fertilizing constituents whatever. If the beet pulp residue is not returned to the land a crop of 14 tons of beets per acre would remove a little more than 300 pounds of mineral matter from the soil, 125 to 150 pounds of which is potash and about 25 pounds phosphoric acid.

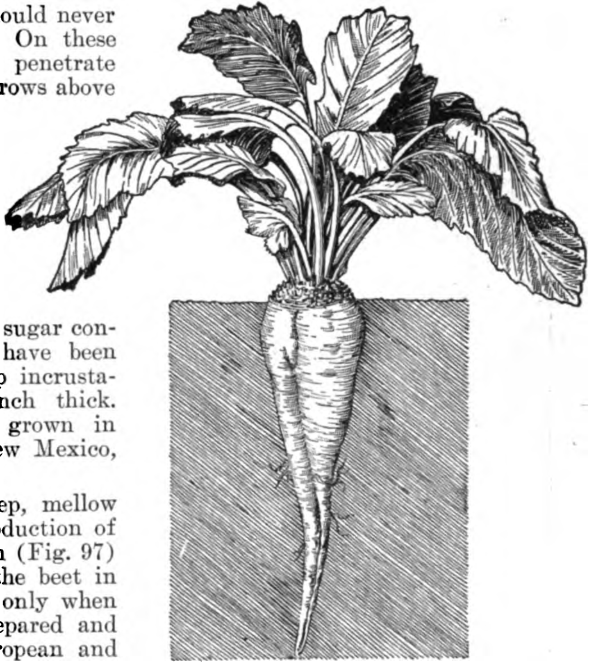


Fig. 97—CORRECT POSITION OF MATURE BEET IN THE SOIL
(U. S. Dept. Agr.)

In the work of the experiment stations stable manure applied to the crop of the preceding year has given greater satisfaction than the use of any other fertilizer. When applied directly to the crop it is likely to increase the yield, but to lower greatly the sugar content of the juice. Very good results are reported when a moderate amount of well-rotted manure has been applied and plowed under in the fall. At the Michigan, New York, Pennsylvania and South Carolina Stations complete commercial fertilizers have been profitably used in growing sugar beets. In many of the

Western States the soils are still so fresh that the application of fertilizers has not been found necessary.

Of the commercial fertilizers, potash and phosphoric acid are most essential. Potash may be applied in the form of the sulphate or the muriate, wood ashes, kainit, etc. Phosphoric acid is best applied in the form of ground bone, superphosphate or basic slag. The use of phosphatic fertilizers has a tendency to increase the sugar content of the juice. Nitrogenous fertilizers, except in connection with phosphoric acid and potash, should be sparingly applied. In large quantities they tend to produce abnormally large beets, which are very low in sugar content. Where commercial fertilizers are used they should be applied in spring and thoroughly worked into the soil before the beets are planted.

In rational farming sugar beets form 1 crop in a systematic rotation. According to Wiley, beets do best after wheat or some other cereal, since these crops are removed in time for fall plowing. The following 4-course rotation is recommended: Corn, heavily manured with stable manure the first year, followed by sugar beets the second, oats or barley the third year, and clover the fourth; then corn again, and the rotation repeated. By applying the barnyard manure to the corn all the weed seeds it contains will be sprouted and killed in the cultivation of the corn, its tendency to produce a rank growth will be lost and the soil will be put in excellent condition for the beet crop. The oats and barley being spring crops, do not require that the beets be removed early in the fall, and the clover can be seeded, as is customary with these cereals. Wiley's rotation is: Wheat, followed by beets; then clover, one crop of which is cut for hay and the other plowed under; then potatoes, wheat and beets again in the order mentioned. In this rotation it will be noticed that the clover follows beets, and must be seeded alone.

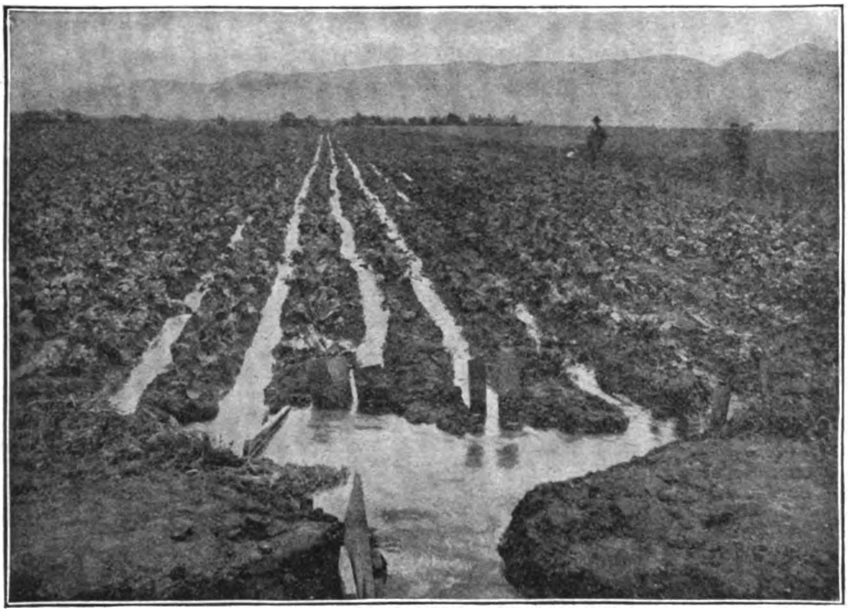


Fig. 98—FURROW IRRIGATION OF SUGAR BEETS IN MONTANA
(U. S. Dept. Agr., Office Expt. Stas., Bul. 86)

Planting and Cultivation—Beets are quite hardy. It is advisable that beet seed be planted as early in the spring as the seed will germinate in the soil. In most States this occurs the latter part of April or first part of May. In Arizona planting from January 1 to February 15 was found most desirable. Plant with a drill in rows about 18 inches apart and cover from ½ inch deep on moist, compact soils or 1½ inches deep on loose, dry soils. In Colorado, where irrigation is practiced, rows 24 inches apart are advised, or, better still, alternate rows 27 and 11 inches apart, with the irrigation furrows down the wider rows.

Sow from 15 to 18 pounds of seed per acre. It is better to sow a little too much than to have a thin stand. The beets should be thinned to stand about 8 inches in the row as soon as they have attained 4 leaves. The Colorado Station has determined that the time of thinning can extend over a period of 2 weeks without harm to the quality of the beets. It is not, as a rule, financially profitable to transplant beets to fill vacancies, and the roots thus grown are fibrous and ill-shaped, though the yield and quality of the roots do not appear to be affected by the operation. Cultivation and weeding of the beets should begin as soon as the rows can be distinguished. Some hand weeding and hoeing is usually necessary. The cultivation between the rows should be level, shallow and frequent throughout the season. The crust should be broken up after each rain. Plan on going over the field with a cultivator about once every 10 days. In the later cultivation the soil should be thrown slightly toward the beets, since all that portion of the root above the soil has a very low sugar content and is cut off in topping.

Irrigation—No conclusive data have yet accumulated on the proper time to irrigate beets or on the amount of irrigation water to supply. Beets of excellent quality are produced by irrigation in all the Rocky Mountain States. At the Arizona Station it has been found advisable to irrigate just before seeding, and again when the plants are 2 or 3 months old. From 4 to 8 furrow irrigations are usually given beets in the arid States. It has been found that excessive irrigation, while producing a large yield of beets, greatly reduces the percentage and total yield of sugar. The method of irrigating sugar beets in Montana is shown in Fig. 98.

Harvesting—Beets are ripe for harvesting when the outside leaves take on a yellowish tinge and drop to the ground. May planted beets are usually ripe in October. The more mature the beets are before being pulled the greater will be the sugar content. The beets may remain in the soil for a considerable time after they have ripened without injury. Even freezing does not harm them if they are held in this state; but freezing and thawing is very injurious. If fall rains occur while the beets are in the ground they are likely to start into a second growth. This causes a decrease in the sugar content. At the Nebraska and Indiana Stations this second growth was prevented by loosening the beets in the bed sufficiently to break the roots. This practice had a favorable effect on the sugar content and percentage purity of the juice. Where this is not done the beets should be harvested and stored before the fall rains come.

Beets are harvested either by special sugar beet pullers or by plowing down one or both sides of the rows to loosen the beets and pulling by hand. The tops are cut off, removing that portion of the root to which the stems of the leaves have been attached. When the beets cannot be delivered at the factory as soon as harvested they should be stored or siloed by putting in long narrow piles on top of the ground and covering with sufficient straw and earth to protect them from frost. At first only a thin layer of earth should be put on or the beets will become too warm, ferment, and lose rapidly in sugar content. Later they should be covered deep enough to keep out frost. When first stored ventilators should be left along the top of the pile at regular intervals so that the heat and moisture of the beets may escape.

Yield and Cost per Acre—The yield of sugar beets has varied in the station experiments from 9 to 30 tons. Eleven to 12 tons per acre is a good average yield. The average yield for all the States in 1902 was 8.4 tons per acre. The cost of growing will vary from $30 to $60 per acre and will average between $35 and $40 per acre. The sugar factories usually pay $4.50 per ton for beets analyzing 12 per cent of sugar in the juice and 80 per cent pure. An additional amount is paid for each increase in percentage of sugar in the beet.

Varieties and Seed—All sugar beets are white. The 2 most commonly grown varieties in this country are Vilmorin Improved and Kleinwanzlebener. The former usually analyzes a little higher percentage in sugar; but the latter gives the higher yields. No mistake will be made in planting either variety.

Most of the sugar beet seed used in this country is grown in Europe, though small amounts are now being produced in this country, and the results have been so satisfactory that the industry is likely to be rapidly developed. This work requires special technical skill and cannot be undertaken by farmers. At the Nebraska Station seed soaked in water from 6 to 24 hours repeatedly failed to germinate when planted during a drouth, while seed soaked in equal parts urine and water at the same time made a fairly good stand.

Uses—Besides the use of sugar beets for sugar production they are also used for stock feeding as other roots are, and the pulp which remains after the sugar is extracted is fed as a coarse stock food. The whole roots are too expensive to grow for stock where corn can be grown for silage. At the Pennsylvania Station it cost 5.17 times as much to produce 100 pounds of air dry matter in the form of sugar beets as in corn. Feeding experiments at the stations (see *Sheep* and *Cattle*) show that while the beets have a higher feeding value than most other roots, they are no better than good corn silage.

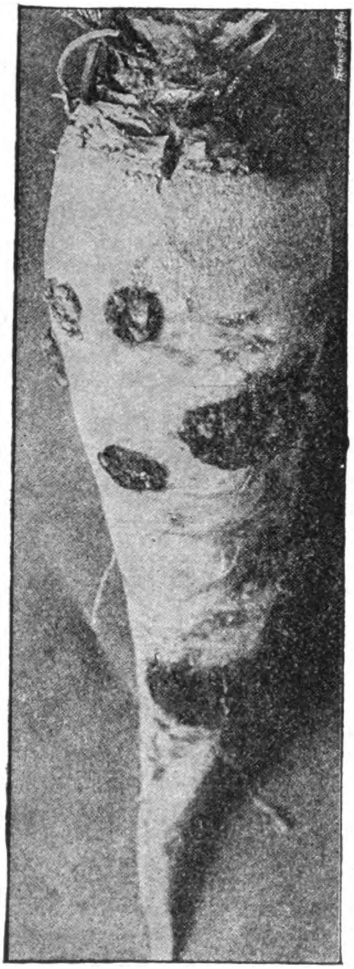


Fig. 99—BEET SCAB

Sugar beet pulp contains about 90 per cent water and 10 per cent solids. Its food value is small, but it has a physiological effect as an aid to digestion like all succulent rations. Good results have been reported with it in feeding experiments with sheep, steers and dairy cows. Cattle may be fed about 50 pounds a day and sheep 7 to 10 pounds per head. As a feed it has a cash value of about 50 to 80 cents per ton. For composition see *Appendix*.

Enemies: Rust (*Uromyces betae*) is to be recognized by the orange powder on affected leaves. The orange rust stage occurs chiefly on seed beets. Diseased leaves should be picked off and burned. Spraying with Bordeaux mixture will check the spread of the trouble.

For Scab see under *Potato*. A beet affected by scab is seen in Fig. 99.

Root Rot (*Rhizoctonia betae*) makes its first appearance at the bases of the leaves, which become blackened. The stalks are weakened so that the leaves fall upon the ground. Later the crown and root are affected and infested parts turn brown. A weft of fungus threads is to be seen on diseased parts. The same fungus may cause a mild form of damping off in lettuce. The disease may be checked by an application of 60 to 70 bushels of lime per acre. The application should preferably be made in the fall.

Leaf Spot (*Cercospora beticola*) begins as brown spots with a purplish margin on the leaves. The spots may increase so as to cover the whole leaf, and finally the leaf and stalk become dry and blackened. Diseased leaves stand more nearly upright and are sometimes curled. New leaves are produced from the center of the crown, which becomes much elongated. The disease may best be controlled by spraying with Bordeaux mixture, the first application of which should be made about the middle of June.

Bacterial Disease is not to be recognized by any changes in the external appearance of the root. Affected plants are less vigorous than healthy ones and the leaves become puffed out between the veins during the progress of the disease. Affected roots become tough, soft and of a yellowish color. The sugar content of sugar beets is considerably diminished. The disease is probably transmitted through infected seed or soil. No direct remedies have been suggested.

WHITE RUST (*Cystopus bliti*) may easily be recognized by the white spots on the leaves. The spots are masses of spores formed by the fungus which lives within the plant. Sugar beets and red beets are attacked. The disease seldom causes such damage as to require treatment.

WATER-CORE SPOTS are sometimes found in the interior of beet roots. There may be from 1 to 10 or more such spots in a single root, and their size may range from that of a pinhead to an inch or more in diameter. The cause of these spots is not known.

Although more than a hundred species of insects have been reported as injurious to beets, only a comparatively small number do enough damage in ordinary years to require special treatment. In the Western States the garden webworms (*Loxostege similalis, L. sticticalis* and *Hellula undalis*) are especially important. The last named species also attacks cabbages and other members of the mustard family. All 3 species cover the plant to some extent with a loose web, under which the caterpillars feed. The first species spins loose webs enclosing nearly all the foliage of a single plant. The caterpillars are nearly white, or dusky colored with black spots. The moth is gray or buff. It is readily attracted to lights. The second species has similar habits and has been reported as especially injurious in Nebraska. Its usual food plant is common lambs' quarters and other related weeds. The eggs are pale yellow and are attached to the leaf surface. The larva forms silken burrows in the earth or in rubbish at the surface as a retreat.

THE IMPORTED GARDEN WEBWORM (*Hellula undalis*) is especially injurious to cabbages and other related plants, and also attacks beets. It is most common in the Southern and Southwestern States. The larva is about 2-3 of an inch long when full grown and is marked with narrow stripes. The moth is about ⅝ of an inch across the wings, of a grayish color, with white and black lines. It is especially injurious during late summer and autumn. The web spun by these webworms is not close enough to protect them against sprays and they are readily destroyed by arsenical poisons.

CUTWORMS and ARMY WORM are frequently injurious to beets, and some species of these insects occur wherever beets are raised. For treatment see under *Cutworms* and *Army Worm.*

FLEA-BEETLES—In this group are included certain leaf-eating beetles with strongly developed hind legs fitted for jumping. The striped flea-beetle is common on cabbage, radish, potato, turnip, strawberry, etc. It is of a shining black color, with 2 yellow lines along the sides. Other common species attack grapes, cucumbers, beets, tobacco, etc. Injury from the tobacco flea-beetle may be largely prevented by clean cultivation and spraying arsenites on trap crops of nightshade or jimson weed. Good results have been obtained in fighting cucumber flea-beetle by spraying with a solution of Paris green and slaked lime, or with Bordeaux mixture. Paris green mixed with flour, lime, ashes, or powdered tobacco has been recommended for dusting on cucumbers. Flea-beetles may be killed or driven away by spraying with kerosene emulsion or the arsenites. Air-slaked lime may be scattered about the roots of grapes to destroy the larvae of the grapevine flea-beetle when they enter the ground. Paris green may be used as a spray at the rate of 1 pound to 50 gallons of water before the buds swell, or 1 pound to 150 gallons of water when the larvae are on the leaves.

A number of species of BLISTER BEETLES are often injurious to beets and may be controlled by spraying with the arsenicals. (See *Blister Beetles.*)

For BEET APHIS upon the roots, see *Plant Lice.*

The prevention of insect injuries to beets is generally to be found in clean cultivation and the proper rotation of crops. Since many of the most injurious beet insects feed upon the common weeds, such as pig-weed, lambs' quarters, purslane, etc., these weeds should be destroyed in the neighborhood of beet fields. It is suggested that beets should follow corn or oats, and not grass, since cutworms and wireworms would be more injurious according to the latter method of rotation.

For sap-sucking insects, such as plant lice, leaf-hoppers, etc., beets may be sprayed with kerosene emulsion or a mechanical mixture of kerosene and water. For leaf-eating insects, such as flea beetles, blister beetles, webworms, etc., the best remedy is spraying with Paris green, arsenate of lead, or other arsenicals. (Ill. Expt. Sta. Bul. 60, and U. S. Dept. Agr. Div. Ento. Bul. 43.)

SUGAR CANE (*Saccharum officinarum*)

A perennial corn-like plant, 6 to 14 feet high, native of tropical countries. Louisiana is the chief sugar producing State of the Union, though cane is grown to some extent in all the Gulf States. The crop is little grown north of Louisiana. About 1-3 of the sugar of commerce is obtained from sugar cane. In 1901 Louisiana produced 270,000 tons of cane sugar, Porto Rico 85,000 tons, Hawaiian Islands 306,000 tons and Cuba 600,000 tons. This was about 1-3 of the total cane sugar production of the world. More than twice as much sugar is now produced from beets as from sugar cane.

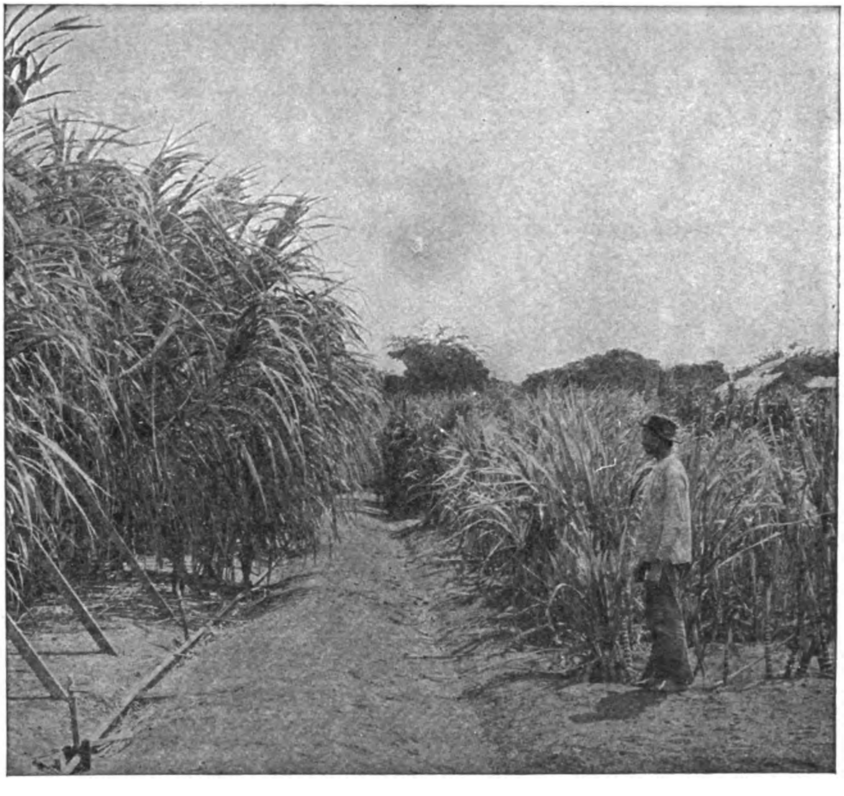


Fig. 100—IRRIGATED AND UNIRRIGATED SUGAR CANE AT THE HAWAIIAN EXPERIMENT STATION
(U. S. Dept. Agr., Office Expt. Stas., Bul. 90)

Sugar cane is propagated almost entirely from cuttings. Only recently has it been discovered that the seed will germinate. The crop does not produce seed in the United States.

Soil—Sugar cane flourishes on rich alluvial bottom lands, but may be grown on any fertile soil in warm climates where water is abundant and the soil is well drained and well tilled. The sugar soils of Louisiana range from loamy silts to almost pure clays. This makes good drainage absolutely essential in that State. The station recommends open drains every 100 feet apart and deep enough to hold the ground water at least 3 feet below the surface soil.

Preparation and Planting—A somewhat systematic rotation is adopted in growing sugar cane in Louisiana and consists of corn, cowpeas and cane. Corn is planted early in the season and cultivation stopped early. At the last cultivation cowpeas are sown between the rows. The corn is gathered early and the cowpeas turned under in August or September. At this time the soil is deeply plowed and thrown into beds or rows 5 to 7 feet wide. After the ground has been put in fine tilth by cultivation the ridges of the rows are furrowed out and the canes planted. Sometimes only 1 continuous line of canes is placed in the bottom of the furrow, but 2 lines have given the best results in the station experiments and are recommended. The canes are covered with a plow, harrow or by hand. When 2 canes are laid side by side in 7-foot rows it requires 4 tons of cane to plant an acre. The use of the upper third of the stalk for seed has given excellent results at the Louisiana Station. As this portion is less rich in sugar than the other parts of the stalk its more general use has been urged.

Planting may be done either in the fall, early winter or spring. Late fall or early winter planting causes an earlier spring growth and is generally preferred in Louisiana. In Florida spring planting is generally practiced. The rows are made 5 to 7 feet apart. In Florida rows 5 feet apart are recommended. After planting the middles of the rows are plowed out to secure better drainage and the soil in cultivation thrown toward the canes. Shallow, clean cultivation until June has given best results. The excellent results of irrigation on sugar cane are shown in Fig. 100.

The buried canes throw out plants at the nodes of the stalk, so that stalks every 6 to 12 inches in the row are obtained. A field once planted to cane may last for many years, depending on the climate, soil, etc. This is true of the fields in Cuba, Hawaii and many other tropical countries. In Louisiana the cane fields are maintained from 1 to 3 years. The canes that grow the first year after planting are referred to as plant cane; those that grow from stubble are first-year stubble, second-year stubble, etc.

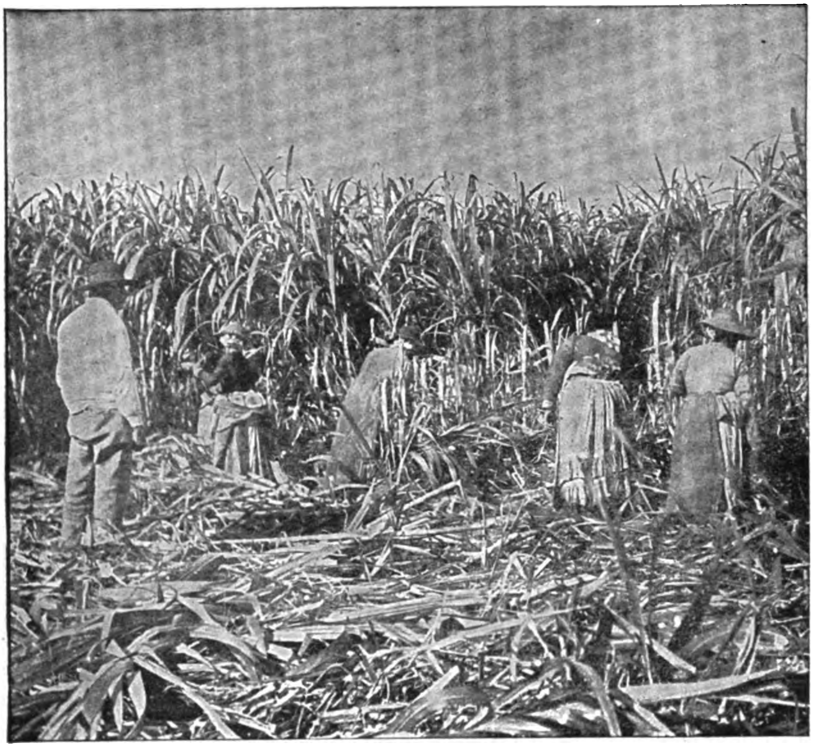


Fig. 101—SUGAR CANE HARVEST IN LOUISIANA

Manuring—Nitrogen and phosphoric acid are the chief fertilizing elements needed in Louisiana soils for sugar cane. The nitrogen is largely supplied by turning under a crop of cowpeas every third year. An excess of nitrogen may decrease the sugar content. Phosphoric acid may be applied in the form of dissolved bone, Thomas slag or acid phosphate. The last is considered the best. About 800 pounds, analyzing 12.5 per cent available phosphoric acid, should be applied per acre. On sandy loam soils where potash is needed about 100 pounds of the muriate will usually be found sufficient. For an account of a number of fertilizer experiments with sugar cane in the Southeastern States consult U. S. Dept. Agr. Bureau of Chem. Bul. 75.

Harvesting—Sugar cane is crushed for sugar in November and December. The leaves are first stripped off in the field and 1 or 2 of the upper joints removed. The crop should be harvested before frosts come. After a splitting freeze the crop should be worked up as rapidly as possible. Some protection is afforded the canes when frost threatens if they are thrown in windrows so that the tops cover the lower parts of the canes in front of them. This method is also recommended when cane is kept over until spring for seed. They should be covered by turning a couple of furrows over them. The yield of sugar cane varies from 10 to 40 tons per acre, and the amount of sugar in a ton of cane from 125 to 300 pounds, besides a considerable amount of molasses. At the Louisiana Station yields of 30 to 40 tons of cane are reported per acre. A sugar cane harvest scene in Louisiana is seen in Fig. 101.

Sugar Making—Cane sugar may be manufactured on a small scale and with comparatively simple machinery; but for economical production and sugar of the best quality an extensive plant is necessary. On a small scale the cane is crushed by some form of roller, the juice brought in contact with sulphur fumes, then neutralized with lime and boiled down to thick syrup. Stirring the syrup induces graining. The grained sugar is separated from the syrup by allowing the syrup to drip or drain into another vessel. For a further discussion of this subject see La. Expt. Sta. Bul. 5 and Fla. Expt. Sta. Bul. 44.

Varieties—The chief varieties of cane grown in Louisiana are the purple and the striped or red ribbon cane. The station tests showed these to be about equally valuable. A seedling variety known as No. 74 has also given excellent results in the station tests. It is a dull green cane with long joints. It yielded 38 tons of cane and the juice contained 16 per cent of sugar. In Florida the station states that red cane is hardier than green and matures earlier, and that for large areas and for sugar the red variety is best, while for small areas and syrup the green cane is preferred. A foreign variety known as Japanese is quite resistant to cold and is recommended for those regions just north of the cane belt. (See also La. Expt. Sta. Bul. 59 and Fla. Expt. Sta. Bul. 44.)

Enemies—Sugar cane is attacked by a number of fungus diseases and by the cane borer and other insects. But little work has been done along this line in the United States. Some of the fungus diseases are carried from plant to plant by the insect pests of sugar. In order to prevent the undue multiplication of the latter, special care should be exercised in giving clean cultivation and in destroying all diseased plants and rubbish in the sugar cane fields.

SULLA (*Hedysarum coronarium*)

A perennial legume, used for forage. Native of Southern Italy. It has been grown to a very limited extent in a few places in this country. It is not injured by a slight frost, but freezing the roots kills it. It requires well-drained land for its best growth. In the Gulf States, where it has given most promise, it is seeded in September or October on well-prepared ground either alone or with winter oats or wheat. The crop comes on the following summer after the grain is removed. It is said to grow from 4 to 8 feet high and to be the equal in feeding value of alfalfa. (U. S. Dept. Agr. Div. Agrost. Bul. 2.)

SUNFLOWER (*Helianthus annuus*)

The sunflower is a native annual, 5 to 20 feet high, closely related to the Jerusalem artichoke. It grows freely from Canada to Mexico. The seed is used for feeding to birds and poultry and to some extent for medicinal purposes to horses and cattle. The silage mixture known as Robertson's mixture is a mixture of sunflower heads, horse beans and corn in the proportion of 2 acres corn and beans to ½ acre of sunflowers. In Russia the oil of the sunflower seed is used for the same purposes as olive oil. The seed is also eaten raw and roasted like peanuts. So far as is known there are no mills for extracting the oil in this country.

Sunflowers grow best, according to the United States Department of Agriculture, for commercial purposes in Kansas, Missouri and the Ohio valley, though many other sections of the country are well suited to the growth of sunflowers. The soil required for the crop is about the same as best suits Indian corn. If it is not fertile, liberal manuring must be practiced. In California sunflowers have done well on alkali soils.

Planting and Cultivation—Prepare the land as for corn. Plant the seed 2 to 3 inches deep in drills about 3½ feet apart, using 10 to 15 pounds of seed per acre. When the plants are about 8 inches high thin to stand 12 to 18 inches distant in the row. The plants are not injured by slight frosts and may be seeded before the corn crop is put in. This gives the heads time to mature before the early frosts of fall. The crop should be given shallow, level cultivation the same as corn. It withstands drouth well and is remarkably free from insect pests and fungus diseases. When the plants are in bloom the field should be gone over and the excess bloom pulled off, leaving only 3 or 4 heads to develop.

Harvesting—The sunflower heads should be harvested before the seed is quite ripe in order to avoid shattering. When the heads have thoroughly dried the seed may be beaten out with a flail or some simple apparatus. No special machinery has yet been put upon the market for this work. The seed should be stored in small bins, barrels, etc., to avoid heating. The yield of seed varies from 800 to 1000 pounds per acre and the price from 2 to 3 cents per pound. A bushel varies in weight from 25 to 35 pounds, averaging about 30 pounds. The seed yields from 15 to 20 per cent of oil by cold pressure.

Varieties—Three principal varieties are grown in the United States. The common sunflower usually grown has no distinct varietal name. The heads of this variety are 8 to 16 inches in diameter and the seed of gray-brown color or striped. The Mammoth Russian produces heads 15 to 20 inches in diameter. The seeds are about ½ inch long, with black or brownish stripes. Sometimes they are all white. This is one of the best varieties for the production of oil. The Black Giant has heads 16 to 22 inches in diameter. The seeds are about ⅜ inch long and black. Russian sunflowers grown in Minnesota are seen in Fig. 102.

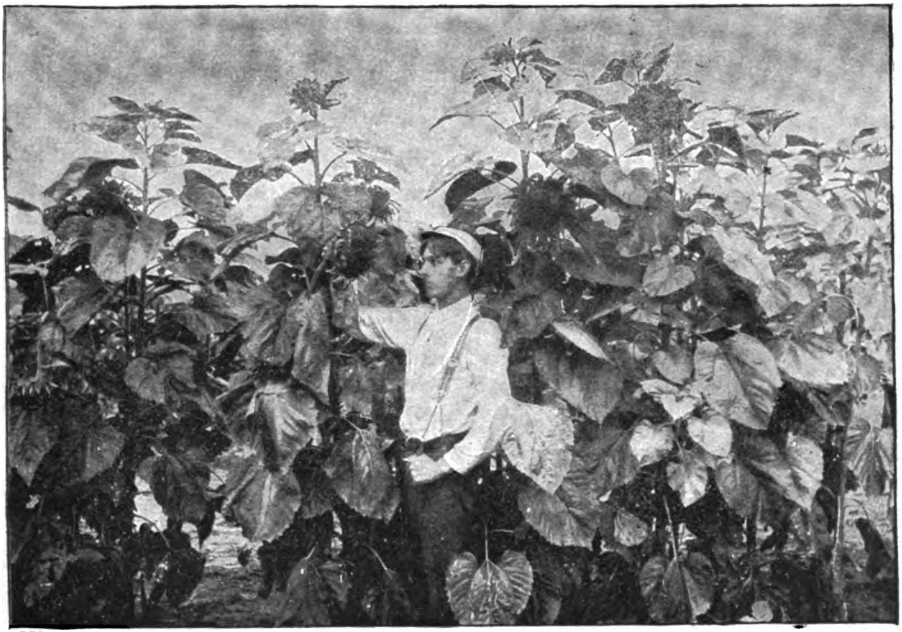


Fig. 102—RUSSIAN SUNFLOWERS GROWN AT THE MINNESOTA EXPERIMENT STATION

Uses—The use of the seed as a bird and poultry food and its value for oil production has been noted above. Results obtained in growing this crop for silage in Maine and Vermont show that in those sections it has no advantages over corn. At the Maine Station the stems of the plant were also ensiled and rendered palatable by this treatment. The yield of green matter has been from 11,000 to 12,000 pounds per acre, containing from 2000 to 2700 pounds of dry matter. At the Canada Stations the butter made when a silage mixture containing sunflower heads was fed was of a richer flavor and higher color than where corn silage alone was fed.

Robertson Mixture—The Robertson ensilage mixture is made by growing together a mixture of horse beans and corn planted in drills at the rate of about 4 seeds per foot or in hills 3 feet apart each way, putting 6 to 10 seeds in each hill. Two acres of this mixture is put in the silo with ½ acre of sunflower heads, cutting both together.. The corn and beans are cut when the corn in the ear is beginning to glaze. Fifty pounds of this mixture should be fed with 4 pounds less grain than is ordinarily given when corn silage is fed. For a further account of sunflower culture see U. S. Dept. Agr. Div. Chem. Bul. 60.

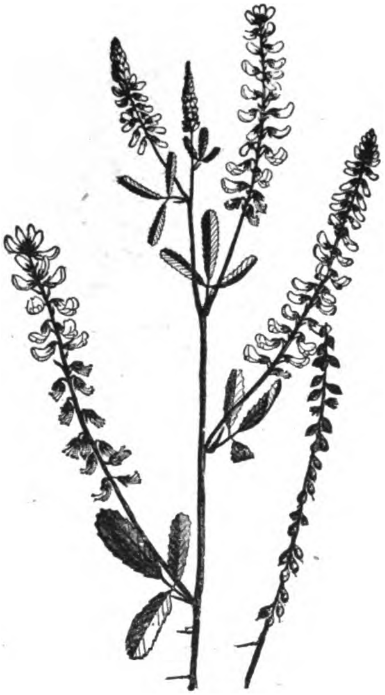


Fig. 103—SWEET CLOVER

SWEET CLOVER (*Melilotus alba*)

Also called Bokhara clover, melilotus, large white clover, etc. A perennial legume, valued especially for green manuring, but also grown to some extent as a forage and bee plant. In the North it is often a weed; in the Southern States it is considered more favorably. The plant grows 3 to 8 feet high and bears many small white flowers. The leaves resemble those of alfalfa. It is a rank grower even on hard, poorly cultivated soils where other legumes would fail. It does especially well on calcareous soils. The plant is not readily eaten by stock, though they may acquire a taste for it and relish it. It is desirable that stock be pastured on it early in the spring before other clovers appear in order that they may learn to like it. The data as to its value for stock feeding are conflicting, stock eating it with great relish in some instances and refusing it in others. There is no division, however, as to its positive value for green manuring. On very poor soils it is often used as a preparatory crop for some more valuable legume. A flowering branch is seen in Fig. 103.

In the South the seed may be sown any time in February or March. Late summer seedings are also made in August. It may be sown alone at the rate of 2 pecks per acre or with oats either in the spring or fall. The seedbed should be well prepared. Ordinarily no covering is required. The winter rains will wash the seed into the soil. If sown in spring a crop may be cut in fall and 2 or 3 crops the following season. For hay it should be cut when about 18 to 20 inches high. If the same land is to be kept in sweet clover for more than 2 years only 2 crops should be cut for hay each season and the third allowed to form seed.

There is a yellow-flowered species of sweet clover (*M. indica*) that is a prominent weed in the grain fields of some of the Western and Pacific States. It has but little value as a forage plant. Another yellow-flowered species (*M. officinalis*) is common throughout the country in waste places.

TEASEL (*Dipsacus fullonum*)

A prickly biennial plant growing about 5 feet high and bearing close cylindrical heads 1½ to 3 inches long. These heads are composed of rigid bracts having elastic hooked points, as seen in Fig. 104. They are used by manufacturers to raise the nap on woolen goods and give the cloth a rough appearance. The culture of teasel in the United States is confined to a very few localities, one of the most important of which is a section about 10 miles square in Onondaga county, New York. Immediately outside of this section the crop is a practical failure. The plant requires a moist climate for its best growth and a heavy clay or loamy soil.

The seed is drilled in rows 3 feet apart in April or May at the rate of a peck or more to the acre. The seed is lightly covered and the plants thinned to stand 6 to 12 inches apart in the rows. Corn is planted in the rows 5 or 6 feet apart for the purpose of holding the snow on the plants in winter, otherwise they may winterkill. The heads are not secured until the middle or last of July of the second year. They are cut off with 3 or 4 inches of the stem and placed on scaffolds arranged with plenty of air circulation above and below to cure. The heads are usually sorted into three grades by the dealers. They sell for from 40 cents to $1.50 per 1000, or by the pound at 10 cents or more. Two hundred and fifty thousand heads, or 1500 pounds, per acre, is counted a heavy yield.

TOBACCO (*Nicotiana tabacum*)

A rank-growing broad-leaved plant, 2 to 9 feet high, used in the manufacture of cigars, smoking and chewing tobacco, and snuff. The plant is native to America and was first made known to the civilized world by Columbus. It is related botanically to such vegetables as the potato, tomato and egg plant. In the United States the plant is an annual. In Mexico and the tropics it becomes perennial. It requires a comparatively short season for its growth; is sensitive to frost, but successfully cultivated as far north as Canada. While it grows this far north and on nearly all soils, its quality is greatly modified by climate and soil and it is of large commercial importance in comparatively few sections.

The principal tobaccos grown in the United States are the cigar types; manufacturing types for smoking and chewing; bright yellow tobacco for cigarettes, smoking and plug wrapper; export types. The cigar types are grown principally in Florida and the States north of Pennsylvania and the Ohio river. The bulk of the export tobacco, including White Burley, is produced in Kentucky and Tennessee.* The bright yellow tobacco, so largely used for cigarettes, plug wrapper, fillers and cutting, is grown mainly in Virginia, the Carolinas and East Tennessee. The total yield of tobacco in the United States is between 800 and 900 million pounds annually. Nearly one-half this amount is produced in Kentucky alone. One-half of the remainder is grown in North Carolina and Virginia in about equal amounts. Then follow Ohio, Tennessee, Wisconsin, Pennsylvania, Maryland, etc., yielding from 65 million pounds in the first named State to 24 million pounds annually in Maryland. A field of half-grown tobacco in Connecticut is seen in Fig. 105.

Soil—The different types of tobacco are grown on soils varying in composition and fertility from the coarse, sandy pine barrens to heavy clay limestones. The heavy shipping tobaccos are grown on soils containing a large proportion of clay, or which for other reasons are very retentive of moisture. Such tobaccos cure to a dark brown or red. On lighter, sandier soils a thinner, more delicate leaf is produced which cures to a bright red mahogany or yellow color. "So marked is this influence of soil upon the quality of the tobacco that a fine, bright tobacco land may be separated by only a few feet from a heavier clay soil which will produce only a heavy manufacturing or export leaf." The kind of tobaccos grown should be adapted to the nature of the soil.

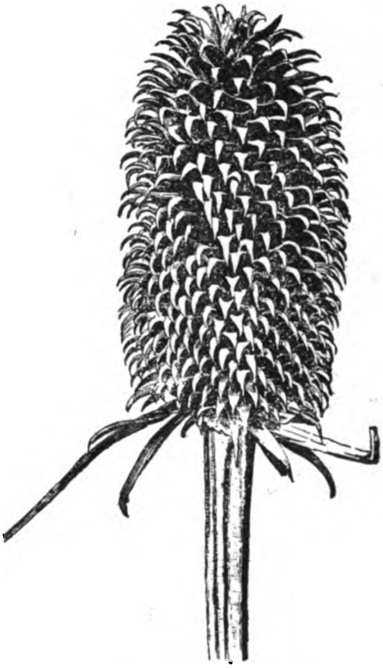


Fig. 104—HEAD OF TEASEL

Fertilizers—The most essential fertilizers in the culture of tobacco are nitrogen, potash and lime. A crop of

1875 pounds of Connecticut seed leaf tobacco requires for its development about 140 pounds of potash, 100 pounds of nitrogen and 100 pounds of lime, and only about 16 pounds of phosphoric acid; about a third of these amounts are in the roots and stems. Contrary to the usual belief, tobacco is no more exhausting to the soil than corn or other grain crops. The addition of fertilizers to soils on which tobacco is grown tends always to increase the yield per acre. Heavy application of nitrogenous fertilizers tends to produce thick, heavy, gummy leaves. This is harmful where it is desired to produce the thin textured leaves or fine bright tobaccos, but very desirable in producing manufacturing tobaccos, since it makes the leaves heavier, richer and of more body.

When smoking, chewing and manufacturing tobaccos are grown, one of the first essentials is to secure a soil well supplied with organic matter, either by applications of barnyard manure or by turning under green manure crops, like cowpeas, clover or crimson clover. If commercial fertilizers are used, tests in Virginia and Louisiana have shown that cottonseed meal and dried blood are better sources of nitrogen than nitrate of soda. Among planters cottonseed meal is the favorite fertilizer for tobacco. Potash is especially desirable in the production of large tobacco crops of good quality and the necessity for its use cannot be too strongly emphasized. High grade sulphate of potash and the carbonate of potash are the best fertilizers of this type. The muriate of potash should not be used on tobacco, since it appears to produce a tobacco containing a relatively large amount of chlorin and of poor burning quality. Applications of cottonseed meal and wood ashes have given good results in Connecticut. In the New England States, when commercial fertilizers are used alone on tobacco, the best growers apply from 1000 to 2000 pounds per acre.

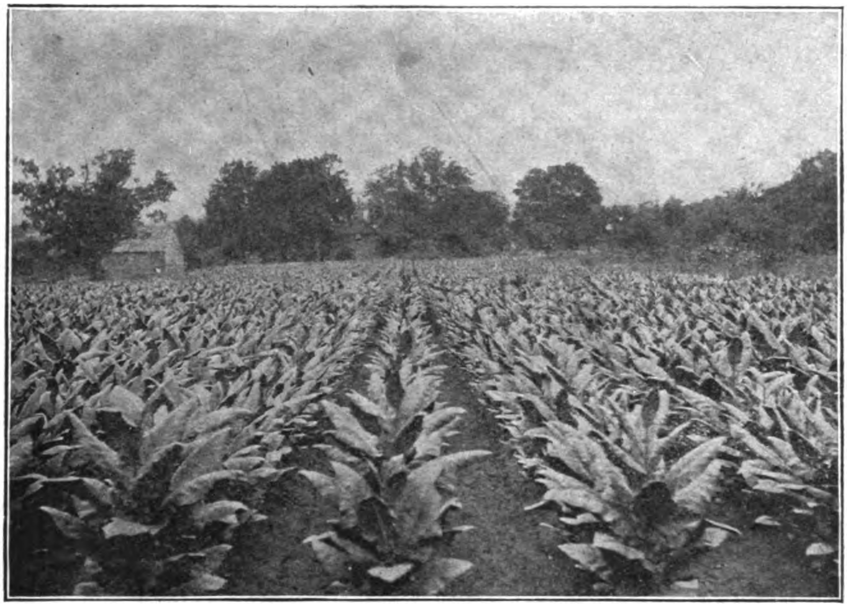


Fig. 105—CONNECTICUT STATE STATION—HALF-GROWN TOBACCO
(U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

Seedbed—Tobacco is grown from seed. Plants for the field are raised by sowing the seed in a hotbed, cold frame or open air beds, depending on the climate of the locality. Newly cleared land is especially desirable for the seedbed, since it is likely to be more free from weed seeds than old land; but clean old land, if very fertile, will answer. The seedbed is usually burned over to destroy more thoroughly all weed seeds, insect eggs and to supply the plants with potash. This is done by piling brush or wood on the bed and letting it burn for about an hour in one place and then moving the fire to another part of the bed. The soil should then be thoroughly worked up and pulverized, care being taken not to bring up any of the subsoil. The seed should be sown upon the ground at the rate of 1 tablespoonful to every 100 square yards of seedbed. This should furnish enough plants to set out 6 or 7 acres. The seed is lightly rolled down or whipped in. In the North the seed is sometimes sprouted before it is sown. This is done by mixing it with moistened rotten wood, placed in a pan and kept in a warm place. The seed should be stirred each day to insure an even germination.

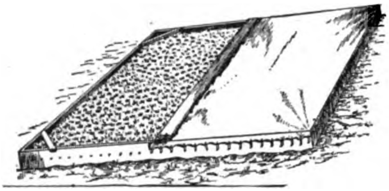


Fig. 106—MOVABLE FRAME FOR PLANT BED

It requires 10 days or 2 weeks for the seed to germinate. Germination is indicated by the white spots on the seeds. The seed may also be germinated in a dampened cloth, kept in a warm place. The seedbeds should be covered with plant or hotbed cloth. This protects the plants from sudden and severe changes of weather, thus enabling them to develop more rapidly, and almost completely protects them from the flea beetles, which often destroy them. The plants should be uncovered after they get a good start and the cover finally left off altogether, at least a week before the plants are set in the field, to harden them off. The young plants are very weak and should be regularly watered with weak liquid manure. Within 5 or 6 weeks after the young plants appear they will be ready for transplanting to the field. A convenient movable frame for a tobacco plant bed is shown in Fig. 106.

Transplanting and Cultivation—The field for tobacco should be thoroughly prepared as for a garden. The rows are usually marked out 3½ to 4 feet apart, the fertilizers used are applied in the row and beds thrown up over them. Hills are made on heavy clay lands about every 3 feet in the row; on lighter lands the elevated beds are sufficient. The distance apart in the row will vary with the kind of tobacco grown; the greater the distance between plants the larger and coarser the leaves. Crowding the plants in the row tends to decrease the size of the leaves and the yield, and produce silkiness and closeness of texture. Cuban tobacco in Florida is grown in 4-foot rows, and set 14 inches distant in the row. The Colorado Station recommends 3 feet by 2 feet for Havana varieties, and 4 feet by 3 feet for larger kinds. The plants are set in the field either by hand (see Fig. 107) or with a planter. The seedbed should be thoroughly watered before the plants are removed, so that they will be less injured in taking up. The plants are large enough to set in the field when the largest leaves are about 2½ inches wide. The crop requires hoeing as soon as the plants become well rooted, followed by shallow cultivation.

Topping, Sprouting and Priming—Topping is the breaking off of the bud at the top of the stalk. This is done when the button is well put out. By this means the leaves grow much larger, ripen up more evenly, and their quality and appearance are much improved. All the plants should be topped uniformly at the same hight. Priming consists in the removal of 4 or 5 of the bottom leaves. It is done at the same time as topping. On sandy soils, where the bright varieties are grown, it is generally omitted, as a protection to the remaining leaves. From 8 to 16 leaves are left on the plants after topping and priming. On very rich lands in Florida it has been found advisable in growing Sumatra tobacco not to top at all, but to allow the plants to go to bloom. Otherwise, too coarse leaves are produced. Soon after topping, sprouts or suckers put out from the axis of each leaf. These should be regularly broken off every week or 10 days.

Fig. 107—SETTING PLANTS BY HAND

Harvesting—Tobacco is harvested by cutting down the whole plant or gathering the leaves separately. The first is the usual method, the latter is believed to be the more scientific since it permits of the gathering of the leaves when they are in the best condition. The crop is considered ripe for harvesting when most of the leaves have turned a greenish-yellow color and become thick and brittle, so that they crack when folded together. This takes place within 80 to 120 days after transplanting. When the whole plant is cut it is usually left to wilt for an hour or more in the field, then carried to the barn and put on a stick. The stems are either speared on nails driven through the stick perpendicular to it, or the tobacco stem is split down from the top nearly to the bottom and put straddle of the stick with the leaves hanging down. The sticks or laths are usually 4½ feet long. The plants are spaced on these about 6 inches apart. The sticks are laid across poles in the tobacco barn, being put 7 or 8 inches apart. When the poles are full they are raised to the top of the barn. The tobacco barn is a closely built structure, well arranged for ventilation. The type of barn commonly used in the Connecticut valley is shown in Fig. 108. Flue curing is practiced with some tobaccos. Where only the leaves are gathered they are brought in from the fields in baskets and strung on pointed wire, which projects at right angles from a wooden stick, leaving about half an inch space between each leaf. In a comparison of these 2 methods by the North Carolina Station, the yield of cured leaf from a half acre, when the leaves were gathered separately, was 454 pounds, worth $68.14; when they were cured on the stalk, a half acre yielded 326.25 pounds, worth but $38.29. The cost of curing by the stalk method was $5.40, and by the leaf method, $9.59. This shows a considerable advantage in curing by the leaf method.

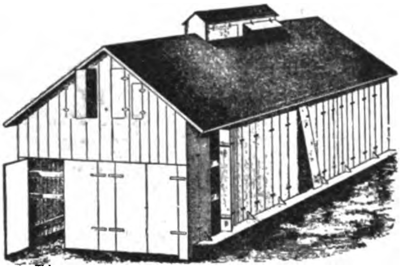


Fig. 108—CIGAR LEAF BARN

Curing—The curing of tobacco is a technical process that can only be described in a general way. The details have to be learned by actual experience. Northern cigar tobacco is usually cut when the middle leaves are ripe and left on the ground 1 to 2 hours to wilt. It is then speared on laths and hung in a tight barn, which is opened on favorable days for ventilation. No artificial heat is used. Thus handled it requires about 2 months for the tobacco to cure. After the tobacco has become thoroughly dried it is taken down on a warm, moist day, put in piles and covered with sacks or blankets for a few days to limber or soften it up. The leaves are then stripped off, sorted into 6 or 8 grades, tied in "hands" and packed in boxes holding about 300 pounds. The sweating or fermentation takes place in these boxes. It is usually managed by the packers rather than the farmers, and the boxes are simply left in the warehouse about a year, during which time the sweating takes place and the tobacco is put into condition for manufacturing.

In Florida, Cuba and Sumatra tobaccos are cured in about the same manner as the Northern cigar tobacco, noted above, but the "hands" after being tied are bulked for sweating. Bulks of tobacco are built up on the floor, or the leaves put in bins. The rooms are arranged so that the heat and moisture conditions can be controlled by steam pipes. The temperature of the room is kept quite high, so that fermentation in the bulks is very active. The bulks are closely watched and as the temperature rises from 130° to 135° F. they are torn down and rebuilt. This is repeated 6 or 8 times, a bulk sometimes having to be rebuilt after being up only 24 hours. The rapidity of fermentation is regulated according to the intended use of the tobacco, whether for filler or wrapper purposes. After thus fermenting the leaves are assorted into 8 grades, tied in cylindrical rolls, made into bales and stored in a warehouse for about 2 years before being used for making cigars. Readers interested in the details of this method of fermentation should consult U. S. Dept. Agr. Rpt. 60.

White Burley tobacco is cured in barns without artificial heat in the same manner as noted above for Northern cigar tobacco. It is extensively used for making plug tobacco, on account of its great absorbing properties. The manufacturers rehandle and resweat White Burley tobacco, so that the grower gives but little attention to this matter.

The bright yellow tobaccos of Maryland, Virginia and North Carolina are usually cured in tight barns with artificial heat, furnished by flues of various kinds. The tobacco is hung in the barn in a fresh state, the fires are started immediately and maintained for about 3 days. The heat is increased very gradually. One of the most common methods of curing is known as the Ragland method, the directions for which are as follows:

(1) Sapping Process—90° F. for 2 to 3 hours, then advancing rapidly to 125°, to remain only a few minutes; then cut off heat and descend to 90°. (2) Yellowing Process—90° for 20 to 30 hours. (3) Fixing Color—100° for 4 hours; then increasing 2½° every 2 hours; then 110° to 120° for 4 to 8 hours. (4) Curing the Leaf—120° to 125° for 6 to 8 hours. (5) Curing Stalks and Stems—125° to 170° by an increase of 5° each hour. Continue at 170° for 12 to 15 hours. After curing the leaves are sorted and the tobacco bulked down and left 2 months.

Dark export or shipping tobaccos are first cut and left on the ground to wilt, then put on sticks and either hung in the barn on scaffolds or left outside a few days to yellow. When the leaves show an even yellow color, slow fires are built on the floors of the barn and the barn kept as hot as it is safe for 4 or 5 days. This dries the leaves. After the fires are removed the sap from the stem runs down into the leaves and in moist weather it is frequently necessary to rebuild the fires 2 or 3 times. After assorting the hands are bulked 4 or 5 feet high and covered with boards or canvas and handled about like the White Burley.

Tobacco Under Shade—Sumatra tobacco of excellent quality is now being grown in Florida on old land by means of shade. The field is entirely covered with cheesecloth, supported on framework about 9 feet high, or with spaced lath. In Connecticut, also, Sumatra tobacco equal to the imported goods is being successfully grown under shade. This method of growing cigar leaf tobacco is expensive as well as very profitable when rightly done. A special study should be made of the subject, and the reader is therefore referred to Conn. State Expt. Sta. Bul. 137, and U. S. Dept. Agr. Rpt. 62, in which detailed directions are given for this highly specialized method of tobacco growing.

Varieties—In Florida, Sumatra for wrapper and Cuban for filler are chiefly grown. The various "seed leaf" varieties are largely grown elsewhere in the North for cigars, chief of which are Connecticut "seed leaf"—broad leaf and narrow leaf. For manufacturing purposes White Burley, Hester, Sweet Orinoco and Hyco are prominent varieties. More than 100 different varieties of tobacco are in cultivation and each has some merits peculiar to itself. No recommendation can be given regarding this point.

Tobacco Stems—This waste product in the manufacture of tobacco is used as a fertilizer. Tobacco stems contain about 8 per cent of potash and 2 to 3 per cent of nitrogen. When steeped in water they make a valuable insecticide for some purposes. (See *Spraying*.) For a further account of tobacco growing see U. S. Dept. Agr. Farmers' Buls. 60, 82, 83; Rpts. 62, 63, 65; "Tobacco Leaf," by Killebrew and Myrick.

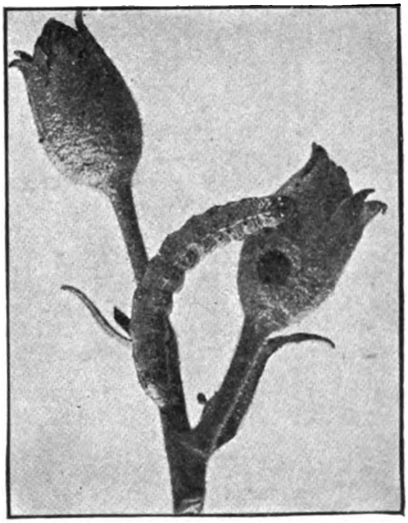


Fig. 109—TOBACCO BUD WORM
(Fla. Expt. Sta. Bul. 48)

Enemies: Leaf Spot (*Cercospora nicotianae*) appears as brown circular spots of varying size on the leaves. The spots sometimes have a white center. Affected leaves turn yellow and die. This disease is also known as "frog eye." It may be controlled by spraying with ammoniated solution of copper carbonate or dusting with sulphur. Treatment should be stopped at least 1 month before cutting the leaves.

White Speck (*Macrosporium tabacinum*) appears as rusty red or brown spots, which later become white with a narrow dark border. Treatment should be the same as for leaf spot.

Pole Burn occurs as small black patches near the veins and midrib of the leaf. The disease spreads rapidly and may cover the whole leaf within 36 hours. It is most likely to appear if the tobacco is cut and hung during warm, damp weather. Special attention should be given to ventilation of the storing houses and to drying them by artificial heat, if necessary.

Stem Rot (*Botrytis longibrachiata*) attacks tobacco in the curing barns and forms white velvety patches on the stems. The leaf finally undergoes extensive rotting. All refuse on the floor of the barns after curing and all diseased stems should be collected and burned and the floor should be dusted with a mixture of equal parts of sulphur and air slaked lime. Barns may be fumigated with sulphur fumes after the tobacco is cured and again just before the next crop is harvested.

Mosaic Disease appears at first as dark green spots near the veins of the leaves. The tissue between these spots turns yellow or, sometimes, white. The dark green spots grow more rapidly than the rest of the leaves and develop into slight elevations. In the field, however. the surface of affected leaves usually remains smooth. As the disease progresses, numerous brown spots are developed on the leaves and the diseased tissue may fall out, leaving holes. Nothing is definitely known concerning the nature of this disease. By different authorities it has been considered due to bacteria, to a "living fluid contagium" and to a contagious ferment. In preventing the disease, it is recommended that attention be given to drainage and proper fertilizers.

Flea Beetle (*Epitrix parvula*) is of a reddish brown color, of minute size, and feeds upon potato, tomato, tobacco, jimson weed, etc. The beetle appears in July and feeds upon the leaves. This beetle is thought to be largely responsible for spreading the 2 tobacco diseases known as "frog eye" and "white speck." The destruction of all weeds belonging to the nightshade family in the neighborhood of tobacco fields, with the exception of a few clumps of such weeds which may be left as trap crops for the beetles, is recommended. These plants may then be thoroughly sprayed with arsenical poisons.

Horn Worm, see under *Tomato*.

Bollworm, see under *Cotton*.

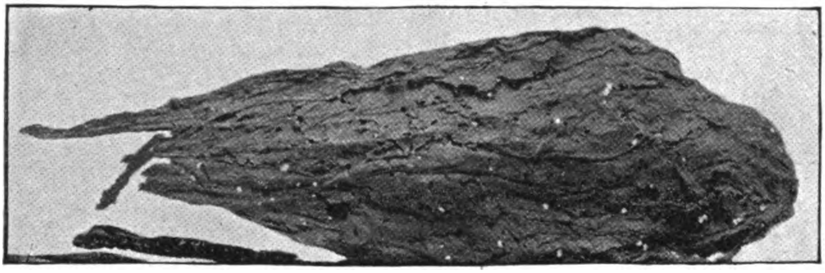


Fig. 110—TOBACCO INJURED BY CIGARETTE BEETLES
(Fla. Expt. Sta. Bul. 60)

Bud Worm (*Heliothis rhexia*) is most injurious in the Southern States. The adult is a greenish moth with stripes across the front wings. The caterpillar attacks the bud of the tobacco plant and when occurring in large numbers causes considerable damage. This insect feeds upon the ground cherry and other related weeds. The bud worm attacks tobacco late in the season, boring into the seed pods and flower stalks as seen in Fig. 109. The eggs are deposited in the bud and the larvae feed on the undeveloped leaves, as well as the seed pods. Spraying with arsenical poisons may be used against these insects, but it is especially recommended that fine corn meal be poisoned with Paris green and shaken on tobacco plants.

Suckfly (*Dicyphus minimus*) is a bug which injures the leaves of tobacco by sucking out the sap. The second and late crops of tobacco are most injured.

Infested leaves turn yellow and wilt or split apart. The eggs of this insect are deposited in the substance of the leaf. Clean culture is regarded as an effective means of controlling the pest. In addition, the use of early trap crops of tobacco which may be sprayed with a strong solution of nicotine, is advised. A number of other related bugs attack tobacco plants at times and may be dealt with in the same manner.

Leaf Miner (*Gelechia operculella*) is a small gray moth which lays its eggs upon the leaves. The larvae are minute in size and bore between the surfaces of the leaves, causing a grayish colored line. In Florida the insect is found from May to October. The larva; when moving from one mine to another, is found on the surface of the leaf and may be destroyed by arsenical poisons. Tobacco is also frequently attacked by cutworms, thrips (see under *Onions*), white fly and mealy bug (see under *Scale Insects*), tree cricket, plant lice, and slugs.

Cigarette Beetle (*Lasioderma serricorne*) is very injurious to cultivated tobacco, feeding in all kinds of dry tobacco and snuff. It attacks also various other dried products and drugs. Leaf tobacco is punctured by these insects and rendered worthless for wrapping purposes. The beetle is found in most tobacco factories. It injures cigarettes and cigars by boring out of them and leaving them perforated with holes, as seen in Fig. 110. The grub of this beetle spins a cocoon of silk and within this cocoon the transformations are undergone. This insect may be eradicated from tobacco establishments by careful removal of all dust and refuse and by fumigation with bisulphid of carbon. Infested buildings may be freed from the insect by steaming the walls after cleaning, or the walls may be cleaned and whitewashed for the same purpose.

VELVET BEAN (*Mucuna utilis*)

The velvet bean is a trailing legume, the vines growing 10 to 50 feet long. The flowers are in clusters at the joints of the stem. The beans are borne in short cylindrical pods, containing 3 to 6 large rounded, brown and white mottled seed. The pods are covered with a black velvety down which gives the name to the plant. The plant was introduced from India, and has been grown in Florida for about 30 years, as an ornamental for covering arbors and unsightly objects. Its great value as a green manuring and forage plant has been discovered only within the past 6 or 8 years. Experiments at the stations in Florida, Alabama and Louisiana show that for the lower half of the Gulf States and for Florida the velvet bean is equal in value to the cowpea, and for some purposes better. North of these States it cannot take the place of the cowpea, since it will not mature seed.

The experience thus far obtained with this crop would indicate that the best method of growing velvet beans is in rows 4 feet apart, putting 2 or 3 beans in hills 2 feet apart in the row. About 1 bushel of seed is required per acre. Light sandy soils are best for this crop but it may be grown as a renovating crop on any soil. Clean cultivation should be practiced until the vines interfere. After that the plant is such a rank, close grower that it is likely to keep down all weeds. Poor soils should first be fertilized with about 240 pounds of acid phosphate and 60 to 100 pounds of muriate of potash. No nitrogenous fertilizers need be applied, since this crop, like cowpeas and clover, is capable of obtaining this element from the air. (See *Leguminous Plants.*) Experiments at the Alabama Station indicate that velvet beans should not be planted between rows of corn, like cowpeas, as the tangle of vines rots the corn and makes the harvesting difficult. In orchards it should not be planted within 3 feet of the trees. A field of velvet beans grown in Florida is seen in Fig. 111.

The Florida Station has analyzed the plants at different stages of growth. The data gathered show that the best time for cutting the vines for hay is from the time the plants are in full bloom until the pods are well formed, but before the beans begin to swell. The crop is harvested with difficulty, owing to the great tangle of vines. A mowing machine with the blades directly in front of the machine, between the wheels, has been used successfully at the Florida Station for this purpose. In other cases a grass hook is used. The weight of cured hay has varied from 5953 pounds in Florida to 8240 pounds per acre in Alabama. From 15 to 25 bushels of beans are obtained per acre in Florida. Usually for feeding the pods are not threshed, but ground with the beans and fed together. The hay is cured by allowing it to lie on the ground about 48 hours after cutting and then placing in small cocks for several days.

The great value of velvet beans as a green manure is shown by a series of experiments at the Alabama Station. Sorghum grown on a plot of ground where a crop of velvet beans had been plowed under yielded at the rate of 7064 pounds per acre, as compared with a yield of 3792 pounds on a similar plot which had not been cropped at all the preceding season. Oats after velvet beans yielded at the rate of 33.6 bushels per acre; after either millet or crab grass and weeds, but 8.4 bushels. The amount of nitrogen furnished by an acre of vines and roots has varied from 131.5 pounds in Florida to 201.3 pounds in Alabama. The roots and stubble on an acre furnish about 12 pounds of nitrogen. It is advisable to cut and feed the vines or pasture them and return the manure to the soil rather than plow the vines and all under.

Velvet bean hay or pasture ranks with cowpea hay or clover for stock, being very rich in protein and thus especially suited for growing animals and the production of milk. The ground beans should be used in the same manner as cottonseed or linseed meal. It is a concentrated feed and should be fed only in small amounts. Hogs are allowed to pasture on the green crop and fatten rapidly. Cattle, hogs and poultry have been fed the ground beans very successfully. The beans are seldom used for human consumption. (See also Ala. Expt. Sta. Buls. 104 and 120; Fla. Expt. Sta. Bul. 60; U. S. Dept. Agr. Farmers' Bul. 102, for a more detailed account of this plant.)

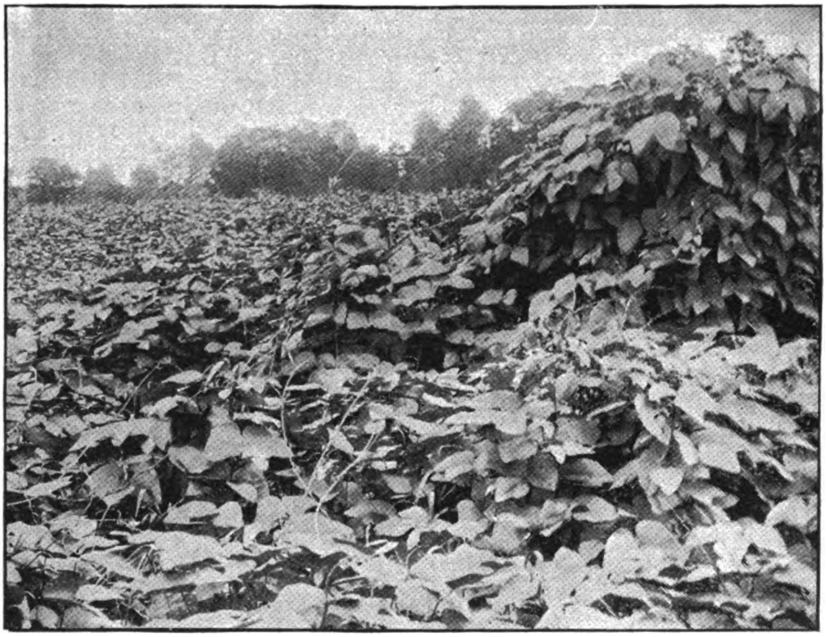


Fig. 111—FIELD OF VELVET BEANS
(Fla. Expt Sta. Bul. 60)

VETCH

There are a number of vetches grown in this country as forage, green manuring, or orchard cover crops; but on account of the recumbent habit of the stems and the high price of the seed, they have never become very popular. They are all leguminous plants and mostly annuals.

Hairy Vetch—One of the more important of these vetches is the hairy or sand vetch (*Vicia villosa*) shown in Fig. 112. This is extensively grown in Europe and has been successfully grown on a small scale nearly everywhere in this country. The plant produces numerous slender branches 3 to 6 feet long. Both leaves and branches are covered with a coat of fine hairs; hence the name. The seeds are small and black. The pods burst open when ripe and reseed the field if not pastured too closely. The crop may be seeded either in autumn from the middle of August to the middle of September or in the spring from the last of April to the middle of May. If grown for forage it should be seeded with rye, oats or wheat. These furnish support for the vines and keep the forage off the ground. Fall sown crops produce some forage before winter comes. If the winter is not too severe it starts into growth very early in the spring, when it may be pastured, cut for hay, or turned under for green manure. If the seed is drilled in, 1 bushel per acre should be sown; if broadcasted, 1½ bushels. The other grains should be seeded with it at the rate of 1 bushel per acre. In cotton or corn fields it should be sown broadcast at the last cultivation and cultivated in.

The crop does best on sandy loams; but will grow well on poor soils and is as good as either cowpeas or clover as a renovating crop. The Michigan Station found the crop especially valuable on poor sandy soils. It is greatly benefited on poor soils by the application of potash and phosphoric acid. The Alabama Station has found it profitable on poor sandy soils to add 240 pounds of acid phosphate and 40 pounds of muriate of potash per acre. On new soils where the crop has never been grown before it may be found necessary to inoculate the soil with the bacteria which form nodules on the roots. (See Fig. 113.) (For obtaining bacteria and method of inoculation, see *Leguminous Plants.*) On inoculated soil at the Alabama Station vetch yielded at the rate of 2545 pounds of cured hay per acre, while on uninoculated soil the yield was but 232 pounds per acre. At that station the nitrogen contained in an acre of hairy vetch harvested when the plant was in full bloom was equivalent to the nitrogen contained in 2571 pounds of cottonseed meal. For that State the station considers it an especially valuable forage crop, since it covers the ground and continues to grow nearly all winter, furnishing pasture from February to May. If not pastured too late it furnishes a good crop of hay. The hay is cured like clover or alfalfa. According to analyses of the crop made at different stages of growth at the Alabama Station, it should be cut for hay 3 or 4 days before the period of full bloom. The yield obtained at the station was 5789 pounds of cured hay. This contained 159 pounds of nitrogen and the roots 20 pounds more.

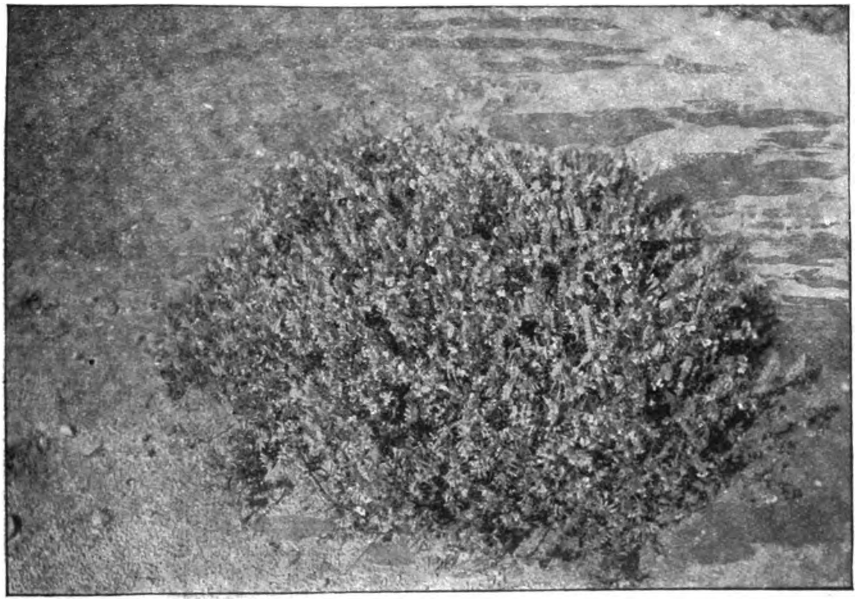


Fig. 112—HAIRY VETCH GROWN IN MINNESOTA

Hairy vetch seeded at the Colorado Station June 10, in rows 39 inches apart, at the rate of 30 pounds per acre, yielded 3⅛ tons of hay per acre. In this case the ground was cultivated 3 times and irrigated once. The plant remained green until December after 2 snows had fallen and the ground had frozen. The crop was readily eaten by cattle and horses and is recommended for pasturage in that State. Hairy vetch is becoming popular in the North as an orchard cover crop and is well suited for this purpose. At the New York Cornell Station the crop remained green all winter. The only objection to it is the high cost of the seed (about $4 per bushel). At present most of the seed used is imported from Europe. It germinates very poorly when over 2 years old. All stock relish the green forage and cured hay. Like the clovers, cowpeas and alfalfa it is a rich fodder especially suited for growing and breeding animals and for milk production. For composition see *Appendix.*

Spring Vetch or Tares (*Vicia sativa*) —This is a trailing, leafy annual, 1 to 2 feet high, that has been tested in nearly all parts of the country. It appears to be an unsatisfactory crop except in the New England and Northern States, where it is grown to a limited extent. The crop should be grown with some cereal like oats or barley to support the vines. Otherwise they lie close to the ground and are difficult to harvest. Seed in April or May at the rate of 5 to 8 pecks per acre mixed with a bushel of small grain. A crop of oats and vetch yields ordinarily 6 to 8 tons of green forage per acre. The crop is cured in the same manner as red clover but requires more care. Its chief value where it can be successfully grown, seems to be as an intermediate crop between the first and second crop of red clover. The crop should be cut in full bloom. It is excellent for soiling purposes and makes a good quality of hay.

The culture of spring vetches is not generally recommended. They are not drouth resistant. The seed is costly and ripens so unevenly as to scarcely pay to gather; and there are a number of other leguminous crops much more satisfactory to grow.

Winter Vetch (*Lathyrus hirsutus*) is similar in habit of growth to spring vetch, being a trailing vine-like plant. It is very successfully grown all through the South, being especially valuable for late fall and early spring pasturage. It has not been found hardy north of Maryland. Like the other vetches, it is sown with rye, wheat or oats at the rate of about 2 bushels of vetch to 1 bushel grain. Seeded in August it furnishes forage in November and December and can be cut for hay in the spring. It should be cut for hay when in full bloom and requires about the same care in curing that cowpeas do.

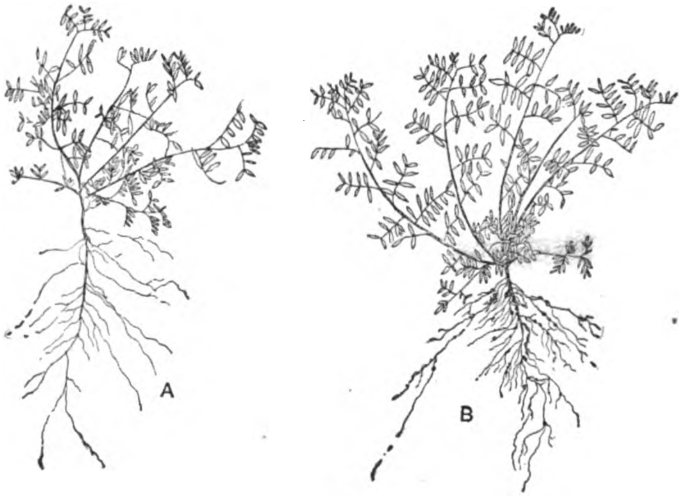


Fig. 113—HAIRY VETCH GROWN ON (*a*) UNINOCULATED AND (*b*) INOCULATED SOIL (U. S. Dept. Agr.)

Kidney Vetch (*Anthyllis vulneraria*) —This crop has been tested at a number of experiment stations but not found promising. It is extensively grown in Europe on thin calcareous soils too poor to grow other crops. It is a perennial legume usually seeded in the fall with grain at the rate of 18 to 22 pounds per acre. It makes some growth after the grain is removed the following summer, but does not give a full crop until the second year. The yield of hay is small and the plant is of little value except on poor, sterile, calcareous or sandy soils too poor for the clovers.

Dakota Vetch (*Lotus Americanus*)—A bushy annual native to the Rocky mountain region of the Northwest, where it often forms valuable wild pasturage and hay.

For a further account of the vetches see U. S. Dept. Agr. Div. Agrost. Cir. 6, upon which this account is largely based; Ala. Expt. Sta. Buls. 96 and 105; N. Y. Cornell Expt. Sta. Bul. 198.

WHEAT (*Triticum sativum*)

Wheat stands second in acreage and third in yield of the cereals grown in the United States. Unlike the other grains, it is grown primarily for human consumption and is only occasionally used for stock feeding. It requires a very fertile soil for its best growth. Rich clays and heavy loams, when well drained, give the heaviest yields, though good results on lighter soils may be obtained when they are in proper condition and the season is favorable. Calcareous soils are also considered good wheat lands.

Preparation of Seedbed—Early plowing for fall wheat is especially desirable. At the Oklahoma Station portions of a field that had been into oats were plowed July 19, August 15 and September 11. The plats plowed July 19 and August 15 were harrowed at intervals to keep down weeds and maintain a loose surface soil. The yield from the plat plowed first was at the rate of 31.3 bushels per acre; plowed second 23.5 bushels, and plowed last 15.3 bushels. That is, the crop was about doubled by early preparation. A wheat harvesting scene in Manitoba is seen in Fig. 114.

The moisture content of the different plats in this experiment was determined 3 days before seeding. It averaged 16.8 per cent for the plat plowed July 19; 13.9 per cent for the plat plowed August 15; and but 7.7 per cent—4 per cent less than the amount required to germinate seed wheat readily—in the plat plowed last. The weeds left to grow on the unplowed plats dissipated the soil moisture and left the ground hard and dry. Moreover, the early prepared plats plowed easily and the ground turned up mellow, while the late prepared plats were hard to plow and the ground turned up hard and lumpy, and was very difficult to bring into condition for seeding. Like experiments at the Minnesota and Michigan Stations, on oat lands, gave very similar results. The heaviest yields were obtained from the early plowed fields, and the cost of preparation was less. "Briefly stated, early plowing, followed at intervals by harrowing, prevents the growth of weeds, conserves the moisture of the soil, keeps the soil in good tilth, and results in the formation of a seedbed best suited for the prompt germination and growth of the seed. The cost of preparing the ground is lessened, the yield of grain is increased, and the practice is financially profitable."

Experiments in deep and shallow plowing for wheat show that depth of plowing is not of so much importance as a firm seedbed, the upper 3 or 4 inches of which is mellow and in good tilth. As with the other cereals, subsoiling is not financially profitable with wheat. Summer fallowing is in favor with many wheat growers. Where the fallow is frequently cultivated, it cleans the land of weeds and makes a good preparation for wheat; but it has been demonstrated over and again that summer fallowing as a farm practice is generally poor business policy. (See *Rotation of Crops.*)

In many farm rotations wheat follows corn. If fall wheat is grown and the corn stover cut for fodder, a couple of cultivations with a good spring tooth harrow will put the ground in good condition for wheat. In sections where spring wheat is grown the seedbed should be fall plowed. In the spring the ground should be run over about twice with a cultivator or harrow before the seed is sown.

Many farmers roll the seedbed. On heavy lands this is of no advantage, but on lighter soils it firms down the seedbed, thus insuring a more even germination of the seed and a more certain contact with the soil water, and would seem to be desirable, especially in dry seasons. In Utah rolling and harrowing after seeding increased the yield a little over 3 bushels per acre. On the value of rolling wheat lands in the West the United States Department of Agriculture states as follows:

"A roller should never be used on the Western plains, except in the case of late plowing, and even then it should be used only before drilling. This is owing to the fact that roughness of surface is valuable for holding moisture and checking the injurious action of dry winds. The seedbed should be made very fine and mellow before drilling, and whenever possible the drill rows should run east and west. Strict attention to such general principles as the foregoing will result in an increase in certain seasons of as much as 5 or 10 bushels per acre."

Seeding and After-Culture—The time for seeding fall wheat in the North varies between the 10th and last of September. In the more Southern States wheat is put in from the middle of October to the middle of November. The aim in any locality is to give the plants a good start before freezing weather sets in. Experiments in Kansas and Oklahoma indicate September 20 as about the right time for seeding in those sections.

Spring wheat should be sown as early in the season as the soil and weather will permit. For best results it is considered a safe rule, with either fall or spring wheat, to sow at a period which is considered early in the locality where the seeding is done. An exception to this occurs where late fall seeding is practiced to escape the ravages of the Hessian fly. (See below.)

Whenever possible wheat should be drilled in rather than broadcasted. Wheat seeded with a press drill at the Iowa Station gave considerably increased yields over seeding with a common drill. Seeding wheat in drill rows far enough apart to allow of cultivation has not given as large yields in this country as by close drilling in the ordinary way. Many experiments at the different stations show that there is very little difference in the results whether wheat is seeded 1 or 3 inches deep. On the drier soils, however, the greater depth will give the better results.

The amount of seed to sow will vary with a number of factors. If the seeding is done early and weather conditions are favorable, the plants will stool better and less seed will be required. Again a bushel of small-grained wheat may contain 2 to 3 times as many kernels as the same amount of large-grained wheat, and hence furnish 2 or 3 times as many plants per acre. All things considered, and one year with another, about 6 pecks per acre will give the best results. If the seeding is done early, and the land is fertile, 1 or 2 pecks less may be used; but if the seeding is late, and hence less opportunity given for stooling, or if the seed is broadcasted, 1 or 2 pecks more may be profitably sown.

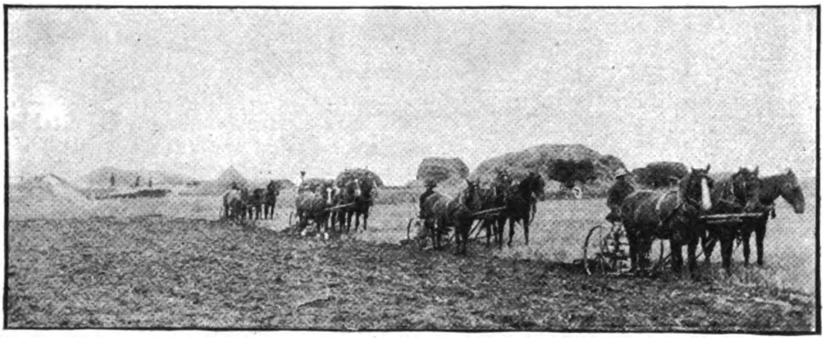


Fig. 114—THRESHING AND PLOWING IN MANITOBA

Fall wheat is sometimes harrowed in the spring. Experiments show that this practice usually results in decreased yields. Pasturing off wheat is not generally profitable. At the Indiana Station mowing the wheat when the plants were about 6 inches high retarded the growth and reduced the yield of both grain and straw.

Manuring—On the rich soils of the Mississippi valley and Western States, the use of commercial fertilizers for wheat has not been profitable. In many Eastern and Southern States, where the soil has become depleted, fertilizers are desirable. In Indiana and Illinois the use of barnyard manure has resulted in better yields of wheat than where commercial fertilizers have been used. Coarse, unfermented barnyard manure should not be applied to wheat; but a dressing of finely composted manure makes one of the best fertilizers for this crop. Where wheat follows corn in the farm rotation the coarse manure should be applied to the corn crop. The manure is thus thoroughly rotted before the wheat is seeded and the weed seeds it contained have germinated and been destroyed. On the ordinarily fertile wheat lands nitrogen and phosphoric acid are the fertilizer elements most concerned in the production of the wheat crop, potash being of less importance.

The following ideal fertilizer formula for wheat is recommended by the Georgia Station for the soils of that State: At seeding time 200 pounds acid phosphate, 50 pounds muriate of potash and 350 pounds cottonseed meal per acre. In the spring a top dressing of 75 pounds of nitrate of soda per acre should be applied broadcast about a week or 10 days before the first heads appear. At the New Jersey Experiment Station the use of 150 pounds of nitrate of soda per acre applied broadcast soon after growth started in the spring nearly doubled the yield. Nitrate of soda should be applied only when the leaves are dry, and preferably just before or just after a rain, so that it will be dissolved for the use of the plants at once.

Wheat does well when sown after catch crops like beans or cowpeas. Clover stubble or any of the legumes turned under make good preparatory crops for wheat, since all these crops leave the soil richer in nitrogen, besides adding humus to it. It has been found more profitable by the Arkansas Station to pick the peas and plow under the vines for wheat than to plow under the entire plant.

In those sections of the country where the use of commercial fertilizers is necessary in wheat growing, the experiment station of the State should be consulted as to the best combinations and forms to use. The stations make it their business to be informed on these points, and their advice may save the buyer money, and at the same time give correct notions as to the rational use of these expensive materials.

Irrigation—In many portions of the West it is necessary to irrigate wheat. Relative to this practice in Utah, the station states that with fall wheat the increase in yield obtained from fall irrigation was not enough to justify the practice. "It would appear, too, that 2 irrigations in the spring is about the proper amount of water to give fall grain on exceedingly dry ground." The same station found that the total yield was about 15 per cent larger on the plats irrigated at night than on plats irrigated during the day. At the Arizona Station furrow irrigation with wheat gave better results than flooding.

Harvesting—The harvesting of wheat should begin when the grain is fully in the dough stage. At this time it can be easily compressed between the thumb and finger, and still is not milky. The cutting should be complete by the time the grain is fully ripe. At the Indiana Station harvesting the grain when in the hard dough stage resulted in the largest yield. If harvesting is deferred until the grain is dead ripe, much grain will be lost by shattering. Where the crop is harvested as soon as the grain is mature, that is, in the hard dough or ripe stage, there is little loss in the feeding value of the straw; but if the harvesting is delayed until the grain is overripe the straw loses much in feeding value and the grain is not improved.

Reapers and self-binders have replaced the cradle almost entirely in this country for cutting wheat, and in some of the Western and Pacific States, on the large wheat farms, machines which gather only the heads of grain are employed. Where the wheat is bound into sheaves, as in Eastern United States, these should be gathered in groups of a dozen or 18 and put in round shocks to cure. Two sheaves are usually spread out and flattened and placed over the top of the shock to keep out the rain. After curing for a few days the sheaves may be stacked or put in the barn until threshing time. A field of wheat in the shock is shown in Fig. 115.

Selecting Seed Wheat—This is perhaps the most important operation in wheat growing. It is quite generally believed among farmers that seed wheat grown on the same farm year after year will deteriorate or run out. Years of careful experiments in Indiana, Pennsylvania, North Dakota, Minnesota and other stations, show conclusively that this idea is wrong. As the result of a study on seed exchange the North Dakota Station states as follows:

"Varieties of wheat do not degenerate because of continuous growth upon the same soil. . . . The theory that wheat culture demands a frequent change of soil is fallacious. . . . Smut and weeds are often introduced by change of seed. . . . Only perfectly formed, plump, hard grain should be seeded, but each farmer should grow his own seed, attempting to bring it to the highest grade of perfection and purity of variety by proper methods of selection and culture without seed exchange. This will insure pure varieties, freedom from smut, less weeds and heavier yielding, better milling qualities." (N. D. Expt. Sta. Bul. 17.)

The Pennsylvania Station states in this connection, that "where the soil, cultivation, manuring and seed selection are not the best it will pay a farmer to change his seed occasionally."

Relative to methods of selecting and improving seed wheat, the United States Department of Agriculture states as follows:

"Begin practicing the constant use of a wheat-breeding plat of 1 acre or more from which to select seed each year. Locate this plat at different parts of the farm every 2 or 3 years, preferably in alternation with clover or other leguminous crops, and give it the best of care. Just before harvest go through a field of a good, hardy, standard variety that has given the best results in the locality, and mark plants that exhibit to the highest degree the special quality which it is desired to increase, such as freedom from rust, fertility of head, or otherwise, and which are at the same time at least as good as the average in other respects. At harvest time cut with a sickle enough of these marked plants for sowing the plat, and, after threshing them, select the largest and most vigorous seed for this purpose, by means of a screen or even by hand picking. Sow the plat early, drilling it at the average rate of about 1¼ bushels per acre. Next season use none of the field crop for seed, but select in the same manner enough of the best plants from this breeding plat for reseeding the plat and use all the remainder for sowing the general crop. In the following season and each succeeding season practice exactly the same method. In this way seed is never taken from the general crop, which cannot be given the same care as the small plat, and there is a constant selection of seed which is more and more rigid every year. Moreover, there is no extra labor involved except the small amount required for seed selection each year. Of course the breeding plat should be kept con-

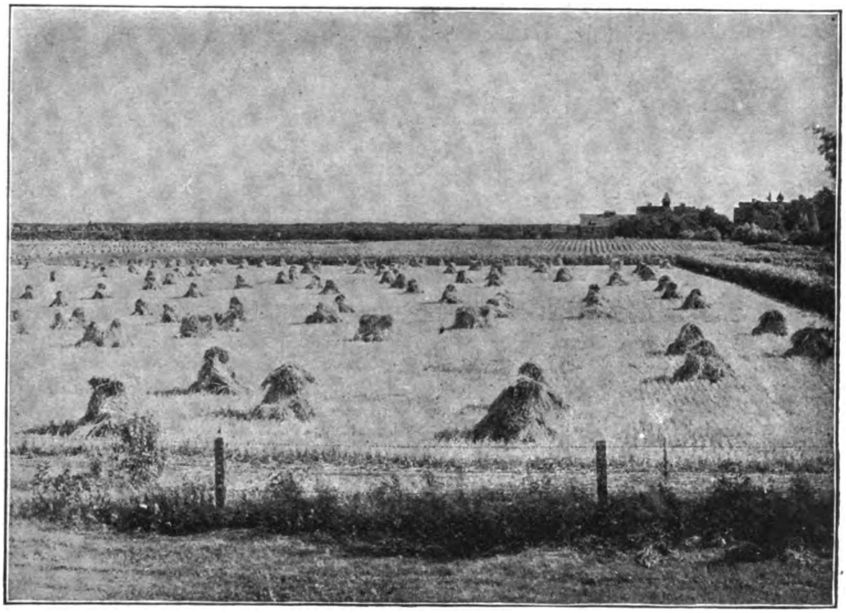


Fig. 115—WHEAT FIELD IN MINNESOTA
(U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

stantly free from rye or other foreign heads and weeds."

Varieties and Botany of Wheat—The discussion here given on this subject is based on the report of the Cerealist of the United States Department of Agriculture. (U. S. Dept. Agr. Div. Veg. Phy. and Path. Bul. 24.) There are 8 well-marked wheat sections in the United States, as follows:

(1) The soft wheat district. This includes mainly the Middle Atlantic and New England States, and portions of Virginia, West Virginia and Kentucky. The best varieties grown are Fultz, Fulcaster, Early Genesee Giant, Jones Winter Fife, Red Wonder, Mediterranean, Early Red Clawson and Blue Stem.

(2) Semi-hard winter wheat district, including Ohio, Indiana, Illinois, Michigan and a small part of Wisconsin. The chief varieties grown are Fultz, Rudy, Early Red Clawson, Poole, Valley, Nigger and Dawson Golden Chaff.

(3) Southern wheat district. This includes Tennessee and portions of Kentucky, West Virginia, North Carolina, South Carolina, Georgia, Alabama, Arkansas and Missouri. In this district either soft or semi-hard wheat is grown. The average yield per acre in this district is but 9 2-3 bushels. The principal varieties grown are Fultz, Fulcaster, Red May, Carrell Prolific, Rice, Everett's High Grade, Boughton and Purple Straw.

(4) The hard spring wheat district comprises the States of Minnesota, North Dakota, South Dakota and portions of Wisconsin, Iowa, Nebraska, Montana and Colorado. Within this area the highest grade spring wheats in the world are grown. But 2 general types of wheat are grown. These comprise the Fife and Velvet Blue Stem wheats. The more important strains of these are Saskatchewan Fife, Scotch Fife, Power Fife, Hayne Blue Stem, Bolton Blue Stem and Wellman Fife. In portions of Wisconsin, Iowa, Nebraska and Minnesota the area of winter wheat grown is extending from year to year, largely through the agency of such robust varieties as Turkish Red, Bearded Fife, Buda Pesth and Bulgarian.

(5) Hard winter wheat district. This takes in Kansas and large portions of Missouri, Oklahoma, Iowa and Nebraska. The chief varieties at present grown in this district are Turkey, Fulcaster, May and Zimmerman.

(6) Durum, or macaroni wheat district. This comprises a large part of the Great Plains beginning with Texas and including most of the country north to Manitoba. Nicaragua is the chief macaroni variety grown. Aside from the macaroni varieties the red grained hard winter wheats, like Turkey, Mediterranean and Fulcaster, are successfully grown in this district. For a further account of these wheats see under *Durum Wheats* below.

(7) Irrigated wheat district, including all the cultivated scattered portions of the Rocky Mountain and Basin States where wheat is grown. The chief varieties now grown in this district are Sonora, Taos, Felspar, Little Club and Defiance.

(8) The white wheat district, comprising California, Oregon, Washington and Northern Idaho. The square head or club wheats are largely grown in this district; but also a number of other varieties. A representative list is Australian, California Club, Sonora, Oregon Red Chaff, Palouse Blue Stem, Palouse Red Chaff, Little Club and Winter White.

The classification of the different groups of wheat has not been fully agreed upon by botanists. According to Kornicke and Werner there are 8 distinct groups. The common bread wheat of the world, and the one most grown in this country, is *Triticum vulgare*. This includes such well-known hard, red grained varieties as the Fifes, Velvet Blue Stem, Turkey, Mediterranean and Fulcaster. Many white wheats and soft winter wheats also belong to this group.

The Club or Square Head wheats (*T. compactum*) are comparatively large yielders. The various varieties are commonly known under the names "Club" or "Square Head." In this country square head wheats are chiefly cultivated in the Pacific Coast and Rocky Mountain States. These wheats have stiff, short straw, seldom exceeding 2 feet high. They therefore stand up well, and seldom lodge. The heads are short and often squarely formed, commonly white, but sometimes red. Both bearded and bald varieties occur. The grains are usually short and rather small. The chaff clings rather tenaciously to the grain, "so that these wheats may be harvested long after ripening without loss from shattering."

The Poulard wheats (*T. turgidum*) are little grown in this country and need not be described. They are largely used in making macaroni and pastes.

The Durum wheats (*T. durum*) are the hardest grained wheats known. The plants are rather tall; the leaves smooth and nearly always resistant to orange leaf rust; heads slender, compactly formed, occasionally very short, and "always bearded with the longest beards known among wheats; spikelets 2-4 grained." The grains are proportionally rather long, have a glassy appearance, and are yellowish-white, occasionally inclining to reddish in color. These wheats deteriorate rapidly when grown in a soil or climate not well adapted to them. Of this wheat Carleton states as follows:

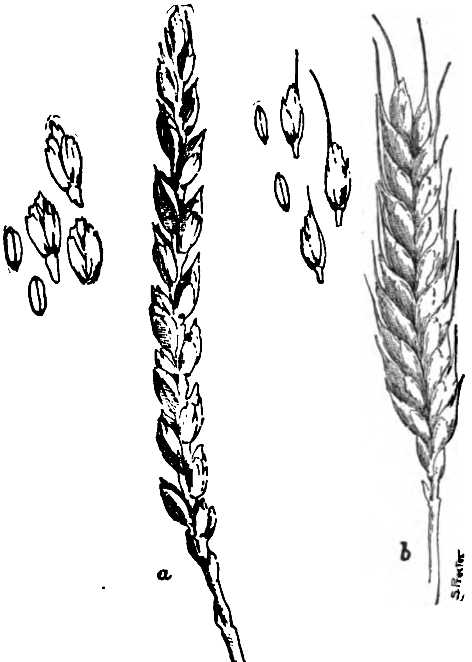


Fig. 116—SPELT WHEAT
a, spelt; *b*, emmer (U. S. Dept. Agr.)

"The durum group furnishes the great bulk of the world's supply of macaroni wheat, though a considerable amount of these pastes is made from Poulard and Polish varieties and a still smaller proportion from the common bread wheats. There is now not the least doubt that some if not all of these durum sorts used for macaroni can be successfully grown in this country, thus adding immensely to the profits of our wheat industry. The success that has attended the trials of the variety Nicaragua in Texas has already conclusively proved the point. At the same time the idea that these wheats cannot be successfully used for bread has never yet been shown to be more than mere assumption. Several mills in this country have successfully ground them, and in Southern Russia, where milling has developed to a high degree of perfection, it is no longer an experiment. In that region durum wheat has become actually the most popular for bread making, though it is usually mixed with a small percentage of ordinary red wheat before grinding. In France there is an increasing demand for durum wheats for all purposes.

"Durum wheats are adapted for soils rather rich in nitrogenous matter but somewhat alkaline, and give the best results in a very hot, dry climate. They are, therefore, quite drouth resistant. Almost all varieties are adapted only for spring growing except in mild latitudes." An exhaustive account of these wheats may be found in U. S. Dept. Agr. Bureau Plant Industry, Bul. 3, by M. A. Carleton.

Of the Polish wheats (*T. Polonicum*) but one variety, White Polish, is widely known. "The plant is usually rather tall, with stems smooth and more or less pithy within. It does not stool extensively. The heads are extremely large and loosely formed, and before ripening are bluish-green in color. A special peculiarity of this species is the rather long, narrow, outer chaff, papery in structure, and standing out slightly from the head, instead of being rigid and closely applied to the spikelets, as in other wheats. The grains are of great size when normal, proportionately quite long, yellowish-white in color, and very hard." This wheat, while requiring considerable moisture at seeding time, is believed to be admirably adapted for cultivation in arid districts, where it has been grown very successfully. The grain is similar in character to the durum wheats.

Spelt (*T. spelt*)—The grain generally called spelt, speltz, spiltz or spelz in this country is really emmer. True spelt is scarcely, if at all, grown in this country. The spikelets of true spelt are usually far apart in the head. They are arched on the inside and stand out from the rachis, forming a loose head. The grain is held tightly within the chaff and is not hulled out in threshing. The difference in appearance between the heads and spikelets of spelt and emmer is well shown in Fig. 116.

Emmer (*T. dicoccum*) is quite generally miscalled spelt in this country. Emmer, however, is a hardier plant than spelt. It has been successfully grown in a number of Northwestern States and promises good results as a drouth and rust resistant wheat. "It will produce a fair crop under almost any condition of soil and climate but thrives best in a dry prairie region with hot summers, where it gives excellent results." Emmer is used as a stock food but not for bread in this country. Analyses of the grain at several stations indicate that it has nearly the same feeding value as wheat. In sheep feeding experiments it has not proved quite equal to barley. (See *Sheep*.) For steers it gave slightly better results at the Canada Stations than a mixed ration of oats, wheat screenings and barley. The emmer was ground with the chaff on in the Canadian experiment. It weighed from 41 to 43½ pounds per bushel. Yields of 25 to 65 bushels per acre are reported by different experimenters and stations.

Both winter and spring forms of emmer are grown and some of the latter are very hardy. Spring varieties are most popular. In Canadian experiments the best yields have been obtained by seeding at the rate of 1¾ bushels per acre. Its culture is entirely similar to that given for wheat above.

Cut green and cured at the Iowa Station, emmer proved no better for forage than any other cereal. Its present value in this country, aside from its usefulness in crossing with easy shelling varieties, will depend on its ability to outyield the other cereals or develop on poorer soils or in a more severe or drouthy climate. For a further discussion of emmer see U. S. Dept. Agr. Farmers' Bul. 139 on "Emmer: A grain for the semi-arid region."

Feeding—For the composition of wheat see *Appendix*.

Wheat is seldom used for feeding to stock, except when the price is unusually low or the grain becomes damaged. It contains a relatively high percentage of protein in proportion to its starch content, and therefore forms a more nearly balanced ration in itself than corn. On the whole, it has proved about 10 per cent less efficient for fattening purposes than corn, but is better suited for young and growing stock than corn.

To horses it should be fed whole. Experiments at the North Dakota Station indicate that it is not desirable to feed it alone. Many of the grains pass through the alimentary tract unbroken, and it is difficult to keep the horses from getting "off feed." Wheat bran and shorts, on the other hand, proved about equal to oats for work horses and mules at the same station.

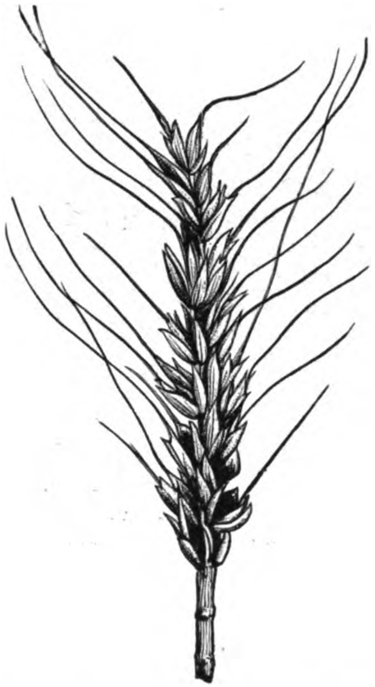


Fig. 117—HEAD OF BEARDED WHEAT AFFECTED WITH SMUT
(U. S. Dept. Agr.)

Experiments at the Ohio Station show that wheat meal, while very satisfactory for fattening steers, is not quite so effective for this purpose as corn meal. For dairy cows wheat meal and corn meal proved about equal in feeding value at the Maine Station; while at the Ontario Agricultural College a mixture of oats, peas and barley proved more effective for milk production than wheat bran.

At the Michigan Station it required about 8 per cent more wheat grain to produce a pound of gain with lambs than when corn was fed. Foreign experiments indicate that whole wheat is nearly as satisfactory a feeding stuff for sheep as oil meal or cottonseed meal.

With pigs the results of tests at 4 stations show that wheat meal is about equal to corn meal for fattening purposes. A mixture of the two gave slightly better results than corn meal alone at the Wisconsin Station. Experiments at the Indiana Experiment Station indicate that wheat for pigs should be crushed or broken before feeding. Soaking the whole wheat did not prove of much benefit. Sheaf wheat fed to pigs at the Oregon Station proved unsatisfactory for fattening purposes, and is not to be recommended. Wheat bran proved only about half as valuable as middlings at the Maine Station.

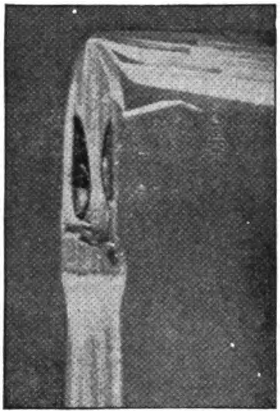


Fig. 118—HESSIAN FLY
Flaxseed stage in broken wheat stem
(Minn. Expt. Sta.)

From these data some idea may be obtained as to when wheat can be profitably fed to stock. Ordinarily it will be cheaper to grow corn for this purpose. Shrunken and slightly damaged grain should always be kept as a stock food. It is practically as valuable for this purpose as the wheat which brings the highest market price. It should be fed in limited amounts, and preferably with other grains.

In mastication, wheat grain and flour form a pasty mass, which adheres to the gums of animals. This can largely be prevented by feeding it with some other material, like bran or shorts. See also under *Cattle, Pigs, Horses, Sheep,* etc.

Enemies: RUST of wheat is of 2 kinds, orange leaf rust and black stem rust. The latter is most injurious, and occurs on wheat, oats, barley and several grasses. In another stage the same fungus lives on the barberry, causing orange spots on the leaves. Fungicides are useless in treating this disease. Rotation of crops and burning over infested stubble are recommended. The appearance of rust is too familiar to require any description.

SCAB (*Fusarium culmorum*) appears on the ears of wheat as an orange or pink coating, fastening the chaff together. The affected part of the ear turns yellow prematurely. No direct treatment is known. The same preventive measures may be adopted as for rust.

STINKING SMUT causes the wheat kernels to swell and they become filled with a black, ill-smelling powder. (Fig. 117.)

LOOSE SMUT is very similar in behavior to loose smut of oats. For treatment of smut see under *Oats.*

HESSIAN FLY (*Cecidomyia destructor*) is a small 2-winged fly, ⅛ of an inch long, of a dark color. It appears in May and June and again in September and October. The eggs are laid on the upper surface of the leaves and the maggots after hatching penetrate into the stalk. The change into the flaxseed stage is made while lying between the sheath and the stalk. The insect passes the winter in the flaxseed stage and emerges as a fly in the spring. Wheat stems are weakened by this insect, so that they break down. (See Fig. 118.) Late seeding, burning the stubble after harvest, the use of resistant varieties, and sowing a small area of wheat early for the purpose of plowing it under after it is 2 or 3 inches high and infested by Hessian flies, have been recommended as preventive methods. A long drouth in early fall retards the second brood, and the seeding time should be regulated accordingly. The time of appearance of the broods is much influenced by altitude and latitude. After the usual date for the appearance of the fall brood of the Hessian fly has been determined for any given locality, the practice should be not to sow wheat earlier than this date.

Joint Worm (*Isosoma hordei*) deposits its eggs in the stems of growing wheat and other cereals. Wheat stems infested by this insect show swellings at and between the joints. These swellings are woody and upon being cut open, cavities are found, in each of which there is a yellow larva of the joint worm. As this insect passes the summer, fall and winter in straw and stubble, much benefit may be derived from burning over the stubble fields. Grain may be cut high and the stubble again cut off close to the ground and raked up for composting or bedding. Where this method is not practicable, stubble should be burned.

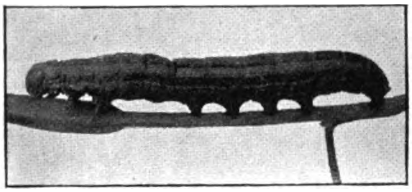


Fig. 119—ARMY WORM, DARK FORM
(N. Y. Cornell Expt. Sta.)

Frit Fly (*Oscinis soror*) is a small fly resembling a housefly in general appearance. The adult is shining black in color and the wings have brown veins. The eggs are laid in volunteer wheat, and late sown wheat is not so subject to attack. Besides the use of fertilizers, it is recommended that all volunteer wheat be destroyed and that wheat be sown as late as possible.

Stem Maggot (*Meromyza Americana*) is yellowish-white with a black spot on the head and 3 black stripes on the abdomen. The adult resembles the housefly, but is smaller. The maggots are found in wheat stems just above the joint. They are green in color and taper toward either end. Insecticides are of no avail against this species. It is recommended that stubble be plowed under or burned annually after harvesting, although these methods are not so effective against the stem maggot as against the Hessian fly and joint worm.

Sawfly (*Cephus pygmaeus*) is a 4-winged fly, about 1-3 of an inch long, of a black color, spotted with yellow. The eggs are laid in May in the hollow part of the stem. The larvae are of a yellowish color. They tunnel through the joints of the stem, with the exception of the one next the ground. At harvest time they penetrate into the root. Rotation of crops is recommended in cases where this insect becomes very troublesome.

Midge (*Diplosis tritici*) lays its eggs on the chaff of young wheat heads, in which position the red maggots feed as soon as hatched. In the fall they make their way to the ground, where they undergo their transformations. Deep fall plowing, rotation of crops, and burning the stubble will check this pest.

Chinch Bug (*Blissus leucopterus*) is 1-7 inch in length, with a black body and white wings, and with a black spot on the wings. The young is at first yellow, later orange, then red. After a few molts the young insect has the appearance of the adult. There are 2 or 3 broods per year. The chinch bug is distributed throughout the whole eastern part of the United States, and as far west as Colorado and New Mexico, and in small areas in California. It feeds almost exclusively on grasses and cereals and is often a serious plague. The chinch bug passes the winter in the adult state in stools of wild grasses and under fallen grass and other rubbish. Usually 3 migrations of the pest are observed annually, 1 in May, another in midsummer and the third in the fall. The adults appear with the first warm days of spring and the eggs are laid on the roots of wheat and other plants. There are 2 forms of the chinch bug, one with much shorter wings than the other. Hot, dry seasons are most favorable for their development, and prolonged periods of damp weather are fatal to the insect, especially on account of the prevalence of fungus and bacterial diseases during such periods. In combating this insect rotation of crops is of limited value for the reason that the chinch bug attacks corn, millet, sorghum, and other field crops, in addition to the cereals and grasses. The distribution of bacterial and fungus

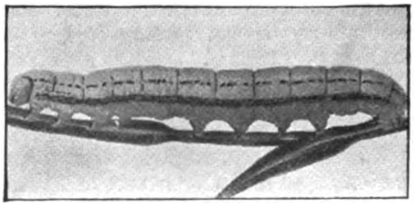


Fig. 120—ARMY WORM, LIGHT FORM
(N. Y. Cornell Expt. Sta.)

diseases, especially of white fungus disease, is not a very efficient means of combating the chinch bug. Several experiment stations keep a supply of diseased chinch bugs for free distribution among the farmers, but the results from such distribution have not been very encouraging. Infested grass lands and stubble fields should be burned over and all rubbish under which the bugs might hide should be destroyed in the same way. They may be destroyed while migrating from one field to another by tar barriers or deep furrows and by being buried under the ground by means of plows or harrows. A narrow strip of grass may be sown around grain fields and turned under as soon as badly infested with the bugs. In corn fields they may be readily destroyed by spraying with kerosene emulsion.

Army Worm (*Leucania unipuncta*)—This caterpillar is an inch or more in length and varies from gray to black in color, with black stripes and narrow white lines on the back, and a greenish color on the under side. The dark form is shown in Fig. 119, the light form in Fig. 120. Fig. 121 shows the moth, pupa and eggs in a grass leaf. It has a wide distribution, but is especially injurious when it becomes so numerous in any locality as to be forced to migrate for food. The caterpillars feed day and night, cutting off stalks of grass, grain, and other plants. In order to prevent their ravages, a wide swath may be mowed about the infested region and burned over. Digging trenches or setting up boards across their path covered with tar or kerosene will check their progress. The forage in front of an advancing army of worms may be sprayed with Paris green or other arsenites. Badly infested fields may be plowed deeply and rolled, for the purpose of destroying the immature army worms in the soil. Spraying with kerosene emulsion is an effective means of killing the caterpillars when on the march. A number of birds feed upon the army worm, among which mention may be made of crows, blackbirds, robins and thrushes. The wheat-head army worm (*L. albilinea*), so called on account of its injury to wheat heads, is a closely related species which may be dealt with in the same manner as recommended for the army worm.

Wireworms—This name is applied to a number of hard, slender, yellow or brown larvae which are frequently seen in the soil about the roots of cultivated crops. They resemble in some respects certain of the myriapods, but may be distinguished by the small number (6) of legs. The adult form of these insects is a click or snapping beetle which, when placed on its back, springs into the air with a clicking sound. In the larval condition the insect lives 2 or 3 years, according to the species, in the ground, and feeds upon seeds and the roots of various plants.

Experiments in soaking seed corn in poisonous solutions and coating it with poisonous or offensive substances indicate conclusively that seed cannot be protected in that way. Paris green, tar, salt, copperas, chlorid of lime, kerosene, turpentine and strychnin were used for this purpose without any effect on the wireworms.

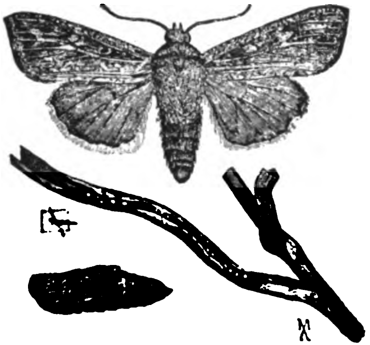


Fig. 121—ARMY WORM
Pupa, moth, eggs in grass leaf
(U. S. Dept. Agr.)

Some farmers have claimed good results from clean summer fallowing, or by planting crops thought to be unpalatable to wireworms, such as buckwheat, mustard and rape. Careful experiments, however, show that wireworms cannot be starved by summer fallowing, although thorough cultivation is unfavorable to their development. Buckwheat is attacked by wireworms, but it does not usually suffer severely. Fall plowing will destroy many of the larvae. The adult beetles may be readily attracted to baits of poisoned clover, poisoned sweetened dough, or sliced potatoes. In limited areas the larvae may be treated with carbon bisulphid, kerosene or crude petroleum in the soil. In some localities good results have been claimed from an application of salt or salty fertilizers to the soil. (N. Y. Cornell Expt. Sta. Bul. 33.)

GRANARY INSECTS—A number of insects are especially injurious to stored grain. The most common and injurious ones are Angoumois grain moth, rice weevil, granary weevil, Mediterranean flour moth, meal snout moth, Indian meal moth, flour beetles, cadelle and saw-toothed grain beetle. As seen from their names, some of these insects are moths and some are beetles. They not only injure stored grain, but attack all sorts of dried food products. It is not considered necessary to describe the different species in this place.

New grain should not be stored in old bins which are known to be infested until they have received a thorough disinfectant treatment. The best treatment for infested grain consists in fumigation with carbon bisulphid. This substance may be poured into shallow pans and set on the grain. It evaporates rapidly and the fumes soon penetrate the whole building. The carbon bisulphid should be used at the rate of 1 pound to 100 bushels of grain. Bins and granaries should be made as tight as possible before treatment and should be kept closed for from 24 to 48 hours. The cost of treatment is only 10 to 15 cents per 100 bushels of grain. Bisulphid of carbon is highly inflammable and care should be exercised accordingly. A lighted match in the vicinity of the fumes will cause an immediate explosion.

PART II

GARDEN CROPS

ROWS OF PEAS A MILE LONG, ST. MARY COUNTY, MARYLAND

FARMER'S CYCLOPEDIA OF AGRICULTURE

GARDEN CROPS

ASPARAGUS (*Asparagus officinalis*)

One of the first vegetables of spring, as well as one of the best grown in the garden. It is perfectly hardy, grows year after year from the same roots, and never fails to produce a crop. As ordinarily grown on the farm, in small beds and hand cultivated, it is a troublesome crop and generally poor in quality. By proper management and horse cultivation, a first-class product should be as easily and cheaply grown as any other garden vegetables. Asparagus does well on almost any good, well-drained soil, but the best results are obtained on deep, rich loose loams. Good corn land will give satisfactory crops of asparagus. It is especially grateful for liberal manuring and good cultivation. Too much manure cannot be given asparagus.

Seeding—Asparagus is easily grown from seed. An ounce will plant about 50 feet of row and furnish about 400 plants. The seed should be sown as early in the spring as the weather becomes settled, in a seedbed of rich loose soil. The drills may be 14 to 16 inches apart, and a few radish seed scattered along to show where the rows are, since the asparagus starts slowly. The bed should be weeded and well cultivated the first season. The following spring the plants will be large enough to transplant to the permanent bed, and this is advisable, but they may be left in the seedbed for another year.

Planting Out—The ground selected for the permanent asparagus bed should have been into some hoed crop the preceding year and well fertilized with barnyard manure. In the spring, from April to June, is the best time for transplanting. Never transplant in the fall. Plow deeply. Set the crowns of the plants from 6 to 8 inches below the surface of the soil—the deeper they are set, the later they will start in the spring, and if set too shallow the roots will push up to the surface and interfere with cultivation. The rows should be 4 feet apart to admit of horse cultivation, and the plants from 18 inches to 2 feet distant in the row. The proper position of the roots when planted out is shown in Fig. 123.

Cultivation and After Care—Cultivate regularly throughout the first season, working the soil toward rather than away from the plants. The tops will be about 3 feet high at the end of the first season. As soon as dead in the fall, remove and cultivate the whole plantation about 4 inches deep, without regard to the rows. The following spring commence cultivation again as soon as the ground will permit.

A few stalks may be cut the spring of the second year, but a crop should not be gathered until the spring of the third year. Cultivation the second year is the same as the first. Cutting should cease by about the middle of June in the Northern States, and a little earlier in States farther south. At this time the whole bed, rows and all, should be thoroughly cultivated 3 inches deep, and a good dressing of well-rotted barnyard manure added. If all sprouts that come up are allowed to grow after this date, they will quickly shade the ground sufficiently to keep down all weed growth. Some growers give a dressing of manure in the fall, but the early summer—late June—is better, since it permits the storing up of a good supply of plant food in the roots during the season for the

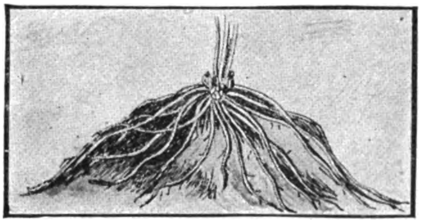


Fig. 123—POSITION OF ASPARAGUS ROOTS AT PLANTING

first growth the following spring. Beds once established and well cared for endure for 20 years or more without renewing. A year's time can be saved in the beginning if plants are bought from seedsmen.

Male v. Female Plants—Experiments at the Ohio Station show that male plants, *i. e.* those that produce no seed, are about 50 per cent more productive than female plants. They are earlier and the shoots are larger, and consequently have a greater market value. These should always be planted when they can be obtained.

Harvesting—In most Northern markets green asparagus is wanted. For this purpose the sprouts may be cut off 2 inches below the surface of the ground when about 6 inches high. Where blanched sprouts are desired, the sprouts may be cut 4 or 5 inches deep. For blanched sprouts the Missouri Station recommends plowing between the rows, turning the land onto the plants, and leaving a dead furrow between the rows. The ridges over the plants should be about a foot higher than the bottoms of the dead furrows. In bunching the sprouts for the market, the tops are placed even with each other, tied at the top and the butts with string, and the butts cut off square. The Ohio Station has found rubber bands cheaper and much more effective for holding the bunches together than strings, and advocates their use. A basket of asparagus stalks ready for bunching is seen in Fig. 124.

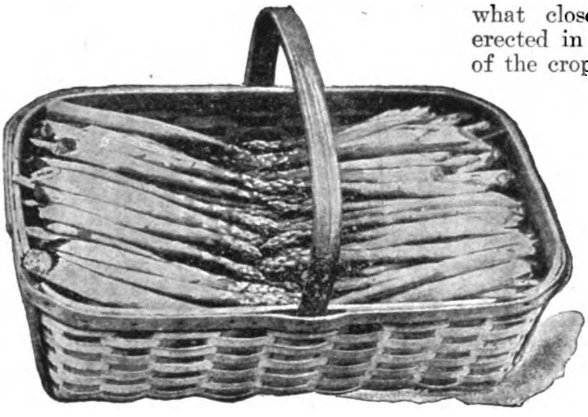


Fig. 124—BASKET OF GIANT ASPARAGUS

Manuring—For the manuring of asparagus nothing equals barnyard manure, applied the last of June, when the cutting season is over. Complete commercial fertilizers have given good results at the New Jersey Station, as well as summer applications of nitrate of soda (160 pounds per acre). Salt is often recommended. While it is of doubtful value as a manure for asparagus, it may be applied in such quantity as to keep down weeds in the row without injury to the asparagus.

Forcing — Four-year-old asparagus roots are frequently taken up in the fall, stored, and later forced in a greenhouse, cellar, hotbed, cold frame, or like arrangement. For this purpose the roots should be set in good soil and well watered, and not forced too fast. Roots thus treated are worthless thereafter, and must be thrown away.

Asparagus is frequently forced in the field. At the Maine Station this was accomplished by the aid of a portable house. The roots were planted somewhat closely and a temporary house erected in March to hasten the growth of the crop. A simpler method is to set boards on edge along each side of the bed and lay hotbed sash across, thus making an ordinary cold frame. The Missouri Station has recently described a successful new method of forcing asparagus in the open field in winter. In this method, trenches are made between the rows by running a double furrow, throwing the soil on the rows of plants, and then making the trenches uniform with a spade. When finished they are 3 or 4 inches lower than the crowns of asparagus. The trenches are covered with 12-inch boards which rest on 4-inch blocks. Two or 3 inches of soil are placed over the boards, and the asparagus bed then covered with 5 or 6 inches of horse manure for the purpose of preventing the heat from escaping from the soil too rapidly. Into the tunnels thus formed steam was blown through a steam hose not to exceed 5 minutes at a time, so as not to heat the earth too hot in any single place. The first day it required about 1 hour of steaming to bring the bed up to the required temperature of 60°. After the first day, it required very little steam. On an average the bed was steamed about twice in 3 days and then only for about 5 minutes for each tunnel. The distribution of the heat throughout the bed was very uniform and steady. Ten days after the heat was turned in, November 14, the first asparagus was cut. Later in the winter it required about 2 weeks for the first crop. Where steam is available, this method of forcing seems to give very satisfactory results at a small cost.

Varieties—Among the better varieties of asparagus are Conover Colossal, Palmetto, Mammoth and Columbian.

Enemies: ASPARAGUS RUST (*Puccinia asparagi*) appears on seedlings and on neglected plants about the first of June. Later, slits are formed in the bark of the plants, from which the rust protrudes. From these rust masses the spore dust is blown away by the wind. Cutting and burning infested plants is a method which has been followed for controlling the rust. The results are not very satisfactory and the plants are often injured by this practice. Rust-proof varieties are much advertised but are not wholly resistant to the disease. Spraying with resin-Bordeaux mixture gives good results. The late growth may be partly protected by spraying with this fungicide and young plants may be saved by spraying twice per week. Where asparagus is cultivated in large areas it will pay to use a power sprayer especially designed for this purpose.

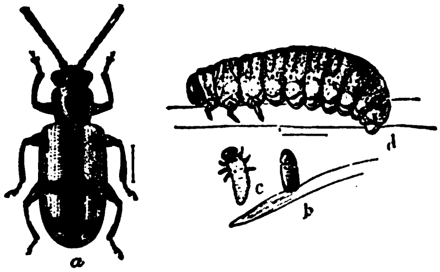


Fig. 125—ASPARAGUS BEETLE
a, adult; *b*, egg, *c*, larva; *d*, larva magnified

COMMON ASPARAGUS BEETLE (*Crioceris asparagi*) (Fig. 125) is of a slender form, bluish-black in color, with red thorax. On the wing covers there are usually 6 small yellow spots. This insect is injurious in both the adult and larval condition, feeding upon the young shoots of asparagus. It passes the winter under rubbish or loose bark and appears in April or May to lay the eggs for the first brood. The time required for the complete life cycle of this insect is about 3 weeks. The number of generations per year varies from 2 to 5, according to climate. A number of parasitic and predaceous insects prey upon the species, but when present in large numbers the insect should be controlled by artificial remedies. Seedlings and voluntary growth should be cut down in the early spring, so that the first generation of beetles is forced to lay the eggs upon fresh shoots which are cut frequently. Thus the eggs are prevented from hatching. A few of the shoots may be allowed to grow and may then be sprayed with the following insecticides for the purpose of destroying the beetles. Fresh air-slaked lime when dusted on plants while the dew is on is an effective remedy against the larvae. The arsenites may be applied dry or in solution in water upon plants which are not cut for food.

TWELVE-SPOTTED ASPARAGUS BEETLE (*C. 12-punctata*) is rarer than the common asparagus beetle but feeds exclusively on asparagus. The adult beetle is distinguished from the other species by its orange red color and 12 black spots on the wing covers. The eggs are deposited mostly on old plants toward the end of shoots. This species feeds especially upon the asparagus berries. The adult beetles eat the tips of young shoots in the spring, but prefer the berry when this can be found. The larva burrows into the berries and feeds on the inside. This species is not likely to become especially troublesome, except to seed growers. When feeding inside of the berries the larva cannot be reached by ordinary insecticides, but the arsenical poisons are effective against both the adults and the larvae when feeding upon the foliage.

Besides these 2 species, a number of other insects depredate to some extent upon asparagus. Among the insect pests mention may be made of 12-spotted cucumber beetle (see under *Cucumber*), tarnished plant bug, bollworm, zebra caterpillar, leaf-footed plant bug and harlequin cabbage bug. (See under *Cabbage.*)

BEANS

For soy beans and cowpeas, see these articles. Common field and garden, or kidney beans (*Phaseolus vulgaris*), Lima beans (*P. lunatus*), Scarlet Runner beans (*P. multiflorus*), and horse or broad beans (*Vicia faba*) will be considered here. The kidney bean in the United States comprises the field, garden, snap and string beans, both bush and climbing, commonly cultivated. The field beans belong to the bush types and are harvested when ripe for the shelled beans, as are also some varieties of snap beans. The climbing sorts are nearly always grown for garden purposes. Typical forms of kidney beans and Lima beans are seen in Figs. 126 and 127.

Culture of Field Beans—Field beans require for their best growth well-drained clay loam or gravelly loam of medium fertility. On heavy soils, or those containing large amounts of humus or manure, beans will mature later and tend to the production of vines rather than seed. If low lands must be used for the bean crop they should be ridged. The seedbed should be well prepared by plowing and harrowing. On lighter soils, the use of moderate amounts of well-rotted barnyard manure will be found one of the most effective fertilizers. The bean belongs to the legumes and is, therefore, able to draw part of its nitrogen from the air. Potash may be applied in the form of wood ashes and phosphoric acid in the form of superphosphate of lime. Experiments at the New York State Station indicate that potash is probably not so important in the growth of beans as was at one time believed, while on poor soils in Georgia plats receiving nitrogen gave the largest yields in every instance. At the New York Cornell Station phosphoric acid in the form of South Carolina rock gave the best results. With bush beans at the Rhode Island Station, the addition of nitrogen in the fertilizers applied was without benefit. Ordinarily it will not be necessary to add nitrogen to the fertilizer formula for field beans.

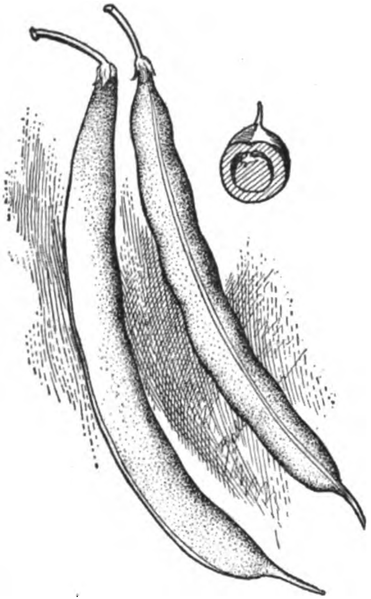


Fig. 126—SNAP KIDNEY BEANS

Beans are easily killed by frost and if planted too early the seed will rot. Nothing is gained by planting before the ground is warm, and in the North this is not much before the first of June. The crop develops rapidly under favorable conditions. Beans may be planted in hills or drills. When planted in drills the rows should be 2½ to 3 feet apart and the beans 3 to 4 inches distant in the row. If grown by the hill method the hills may be 15 to 18 inches apart, with from 4 to 5 beans in each, the same width rows being used as for drills. During the season frequent shallow cultivation will be required, not only to furnish plant food and keep down weeds, but for the important purpose of preserving soil moisture. Care should be taken not to cultivate the beans when they are wet, as the dirt sticks to the leaves and spots them.

Where large crops are grown, the plants are pulled when the pods are ripe, by running a plow along one side of the row with a special kind of point which cuts off the vines just below the surface of the ground. Men follow with pitchforks and throw the vines together in small piles, where they are left for a day or more to cure. Machines are now on the market that pull 2 rows of beans at a time and throw them together. (Fig. 128.) Where the crop is very weedy or machinery is not available, the vines are pulled by hand. Care needs to be taken in curing not to allow the vines to get wet, as this discolors the beans and lowers their market value. When the vines are thoroughly dry they are run through a thresher with special concaves, or threshed out with a flail. They are then further cleaned by running through a fanning mill, after which all discolored beans, as well as stones, dirt, etc., are picked out by hand. This latter work is usually performed by children, women or other cheap labor. The leading varieties of field beans are White Marrow, Navy, Medium and the Kidneys. The yield of different varieties varies greatly in different localities. Tests should therefore be made of a number of varieties to see which is best suited to the locality in question. In bean growing districts when all beans are cheap they may be used for feeding. Ordinarily, beans are too costly for stock feeding. They are rich in protein. To sheep they may be fed whole, uncooked, but only as part of the ration; for hogs and other stock they should be cooked and it is advisable to mix them with such material as corn meal. (See also N. Y. Cornell Expt. Sta. Bul. 210.)

Garden Beans—These require a much richer soil than field beans, the best garden soil being none too good for them. They will also stand heavy fertilizing, especially the pole sorts. The bush-forms are planted in the same manner as the field sorts. Where the pole or running varieties are grown the poles should be set about 4 feet apart each way before the beans are planted, and 4 or 5 beans planted 1½ inches deep about each pole. In the absence of poles, posts may be set and 2 wires, one 4 inches from the ground and the other about 6 feet, stretched tightly between. Sheep twine may then be tied between the wires for the vines to run on. Of the bush varieties grown for snap or string beans, the most popular of the green podded sorts are Early Valentine, Stringless, Early Mohawk, and Refugee; of the yellow podded varieties, Black Wax, Golden Wax, Kidney Wax and White Wax. For a succession throughout the season, varieties may be planted every 2 or 3 weeks in the Northern States up to August 1. Horticultural or Speckled Cranberry and Golden Cluster are good pole or running varieties of the kidney beans. Pole beans have been very successfully grown under glass at the New Hampshire Agricultural Experiment Station. (See N. H. Expt. Sta. Bul. 62.)

Of the pole types of beans the most popular at the present time are the Limas (*P. lunatus*). There are a number of different types of this variety, including the dwarf forms. Each of these forms has been monographed by the New York Cornell Experiment Station. (See Buls. 97 and 115, where detailed culture methods may be found.) The Limas are extensively grown on a commercial scale in California. The shelled beans are eaten either ripe or green. The pole varieties do not mature with certainty in the Northern States, but the dwarf forms are quite certain and are very popular. The Scarlet Runner bean (*P. multiflorus*) is, in this country, primarily an ornamental vine, though the beans are edible as shelled beans.

The common forage bean of Europe is the English, broad, or horse bean (*Vicia faba*) (Fig. 129). It is an erect growing plant with large flat usually rounded seeds. It has been planted as a forage crop at several stations but has not proved successful in our hot dry summers. In Canada it is ensiled with corn, making a silage known as the "Robertson Mixture." (See *Silage.*) It is much less sensitive to frost than other sorts and therefore can be planted much earlier in spring. Plant in stiff clays or clay loams in drills 18 to 24 inches apart, using 6 to 8 pecks of seed per acre, cultivate shallow between the rows until the vines touch. On good soil the yield is 25 to 30 bushels per acre. The beans should be ground before feeding to stock.

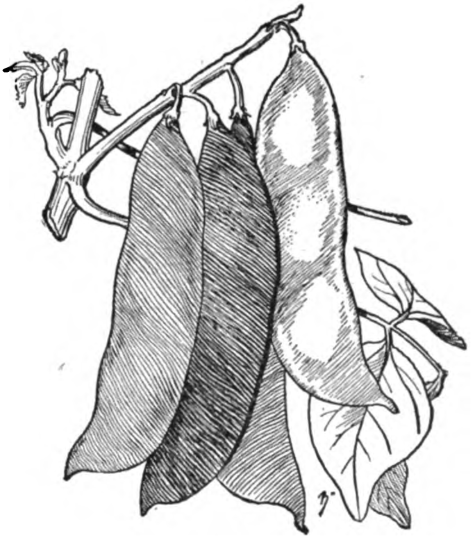


Fig. 127—LIMA BEANS

Enemies: ANTHRACNOSE (*Colletotrichum Lindemuthianum*) appears on the pod in the form of dark colored pits, and greatly decreases the yield of beans. It spreads rapidly from pod to pod after gathering. The disease passes the winter in the bean, and when infected seed is used the plants themselves soon give evidence of the disease by shriveling up or failing to develop. This disease is common on Scarlet Runner and French beans. Badly diseased pods are often contorted. The fungus which causes the disease is sometimes parasitic on cucumbers, pumpkins and muskmelons. This disease may be checked by spraying with Bordeaux mixture when it first makes its appearance on the leaves. The badly affected plants should be removed and destroyed. Infected seed may often be recognized by their shriveled and discolored appearance and should be rejected. Experiments have shown that bean seed can be safely treated by soaking in water at a temperature of 140° F. for 5 minutes, or at 130° F. for 15 minutes. No harm will result to the seed from soaking in Bordeaux mixture 1 hour, ammoniacal solution of copper carbonate 1 hour, or potassium sulphide (1 ounce to 2 gallons of water) 1 hour. The hot water treatment gives perhaps the best results.

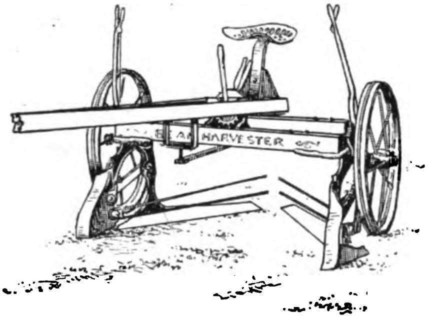


Fig. 128—BEAN HARVESTING MACHINE

Lima Bean Mildew (*Phytophthora phaseoli*) attacks especially the pods, but sometimes the leaves and leaf stems. It is often seen on young shoots. Diseased pods exhibit white felted patches, which sometimes extend over the whole surface. The young shoots become swollen and distorted. The disease may be controlled by spraying with Bordeaux mixture.

Blight (*Bacillus phaseoli*) occurs in Lima beans and forms spots on the pods and leaves in the earlier stages of the disease. The spots have a reddish-purple border, enclosing an area of red. The disease may be propagated by planting infected seed, and the best preventive remedy consists in the selection of healthy seed. For powdery mildew see under *Peas*.

Rust (*Uromyces phaseoli*) occurs on the leaves, pods and stems of garden and other beans. It is not as destructive to beans as either anthracnose or blight. The rust forms small brown spots of a nearly circular outline on the foliage. The spots sometimes change from brown to black. The parasitic fungus which causes the disease grows inside of the leaves, and treatment cannot be administered after the rust spots appear. It is possible that the fungus winters over in rusted leaves, and diseased plants should be destroyed in order to prevent its distribution.

Weevil (*Bruchus obtectus*) closely resembles the pea weevil, but is smaller, being about ⅛ of an inch long and nearly black. The eggs are laid on the outside of young pods, and the larva upon hatching makes its way into the bean, where it passes the remainder of its life, and emerges as a weevil in the following spring. Several weevils may be found in a single bean. The weevil may continue to breed for several generations in seed beans, and no benefit, therefore, is to be derived from holding over the seed for planting. Fumigation with carbon bisulphid, as recommended under *Granary Insects* (see *Wheat*), or subjection to heat, will give the best results. Before planting, infested bean seed may be thrown into water, when the infested seeds will float upon the surface.

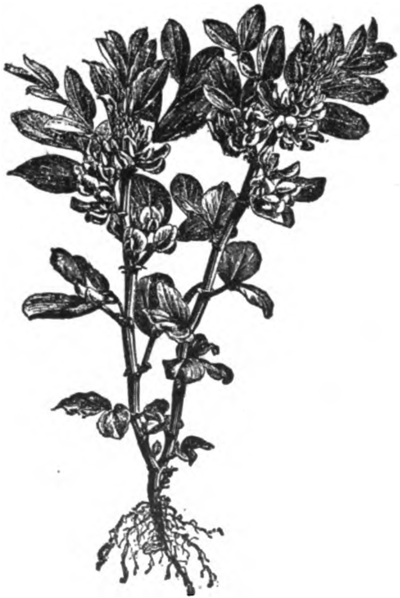


Fig. 129—ENGLISH HORSE BEANS

A closely related species known as the European bean weevil has recently been introduced into this country and has established itself in Texas and neighboring States. The 4-spotted bean weevil is distributed chiefly in the southern part of the country and attacks beans and cowpeas. The same remedies should be applied to this as recommended under common bean weevil.

ASH GRAY BLISTER BEETLE (*Macrobasis unicolor*) is slender, soft-bodied, and of a uniform ash gray. The beetle injures beans and peas by eating the leaves. A large number of food plants are also attacked by this species. Where the blister beetles occur in large numbers on potatoes they may be destroyed by spraying with Paris green, either alone or mixed with flour or plaster. Paris green, however, cannot be used on beans in sufficient strength to kill the beetles without injuring the beans.

NUTTALL'S BLISTER BEETLE (*Cantharis Nuttalli*) is bright metallic green in color, with a coppery luster on the head and thorax. It is found from the Mississippi River to the Rocky Mountains. The beetle appears in large swarms and may destroy a patch of beans in a single day. They may be combated by sweeping into a net, by beating into pans of water on which a thin film of oil is poured, or by driving them into windrows of straw and burning.

BEAN LADYBIRD (*Epilachna corrupta*) is one of the few species of ladybirds which has the habit of eating plant substances. Nearly all of these insects, as is well known, feed upon plant lice and other insects. The color of this species is yellowish-brown, and each wing cover bears 4 black spots. It is particularly injurious in the Western States. Hand picking of the beetles and their eggs is recommended, and spraying with kerosene emulsion on the underside of the leaves is an effective remedy.

BEAN LEAF BEETLE (*Cerotoma trifurcata*) is most injurious in the Gulf States. The beetle is about 1-7 of an inch in length and varies in color from pale yellow to red, with black markings upon the wing covers. The beetle feeds on beans and cowpeas. This species is slow of movement and hand picking is therefore indicated as a valuable remedy against it. Pyrethrum is also recommended. The native food plants of this species are tick trefoil and bush clover, and these plants should be destroyed in the neighborhood of bean patches so as not to serve as an attraction for the beetles. Besides these species a number of plant lice, plant bugs, leaf-hoppers and other insects are occasionally injurious to beans. The bollworm sometimes does great damage. The bean leaf roller (*Eudamus proteus*) attacks beans and related plants, especially in the Gulf States. This caterpillar may be destroyed by spraying with Paris green on early beans planted as a trap crop.

BEETS (*Beta vulgaris*)

Young table beets are extensively cultivated for market. For this purpose the smaller round or half-round forms are most in use. For the main crop of table beets the long or half-long varieties are generally grown in field culture. The long beets were formerly grown to a considerable extent as stock beets, but are now largely superseded for this purpose by the mangel-wurzel, which is a much larger and more productive form of beets. Sugar beets were derived from common beets and the sugar content increased to its present high standard by selection. They are treated under the heading *Sugar Beets*. Table beets, including field varieties and mangel-wurzels, will be considered here.

Table Beets—Good crops of beets can be produced on almost any good friable soil that is well drained. A fertile clay loam is productive of the heaviest yields. Lighter soils produce earlier crops. The land, where possible, should be deeply plowed in the fall. In the spring it should be well worked down with a cultivator and harrow and put in fine tilth. Beets are hardy, and for the early crop may be sown just as early as the land can be worked. In market gardening practice the rows are sometimes as close as a foot apart and the beets planted 1½ inches deep and thinned to stand about 6 inches distant in the row. The thinning is left until the young beet tops have attained some size so that those pulled out may be used for greens. The crop is kept free from weeds and the soil loose by frequent cultivation with hand cultivators and hoes. In field culture table beets are grown in rows 18 inches to 2 feet apart to admit of horse cultivation, and the beets thinned to 8 inches apart. Beet seed will germinate much more rapidly if hot water is first poured on it and the seed left to soak 6 or 8 hours before planting. Garden beets may be planted any time in the North up to the middle of June. Field table beets require the whole season to mature. When gathered in the fall they are stored in cool cellars or pits and will keep nearly as well as potatoes. Young garden beets when of a salable size are bunched like radishes and sent to market. Some of the best early varieties are Early Blood Turnip; Edmond, a quick growing, round, smooth variety with red flesh and small tops; Egyptian Turnip, a standard sort, productive and early and of a deep crimson color; Eclipse, uniform globular shape, fine grained, good quality, bright red; Bastian, a second early variety, following Egyptian and Eclipse. Of the long field varieties of table beets, Long Smooth, Blood Red and Henderson Half Long are good varieties.

Fertilizing Garden Beets—In manuring beets coarse fermenting fertilizers should not be used. Well-rotted barnyard manure is especially effective and one of the best fertilizers for beets. In Rhode Island lime has been found very beneficial with beets grown on acid soils. The effect of liming on acid soil is shown in Fig. 130. Potash fertilizers are also effective for this crop. Experiments at the Massachusetts Hatch Station indicate that the sulphate produces better garden beets than muriate of potash. Applications of salt at the same station and in Florida on a dry, sandy soil seemed also of benefit to this crop. From 200 to 300 pounds per acre may be used. For the production of the early crops some quick acting nitrogenous fertilizer seems especially desirable. Nitrate of soda is one of the most effective forms. It proved much superior to cottonseed meal for this purpose at the Georgia Station. At the New Jersey Station the use of from 400 to 700 pounds of nitrate of soda, applied just before the plants were set out and thoroughly worked into a truck-gardening soil already rich in all the elements of plant food, increased the earliness of the first 3 gatherings 63, 135 and 17½ per cent, respectively, and the yield from 10 per cent with the smaller amount to 23.7 per cent with the larger amount. Where earliness is a factor of primary importance, as in market gardening, nitrate of soda can be used at a profit with this crop even on the richest soils. The smaller varieties are sometimes forced in greenhouses. For the early crop for market young plants should be grown either in the greenhouse or hotbed and transplanted. The use of electric light in forcing beets was beneficial at the New York Cornell Station, but gave unfavorable results at the West Virginia Station. The Massachusetts Hatch Station studied the effect of a current of electricity passing through the soil on the growth of beets. It was unfavorable.

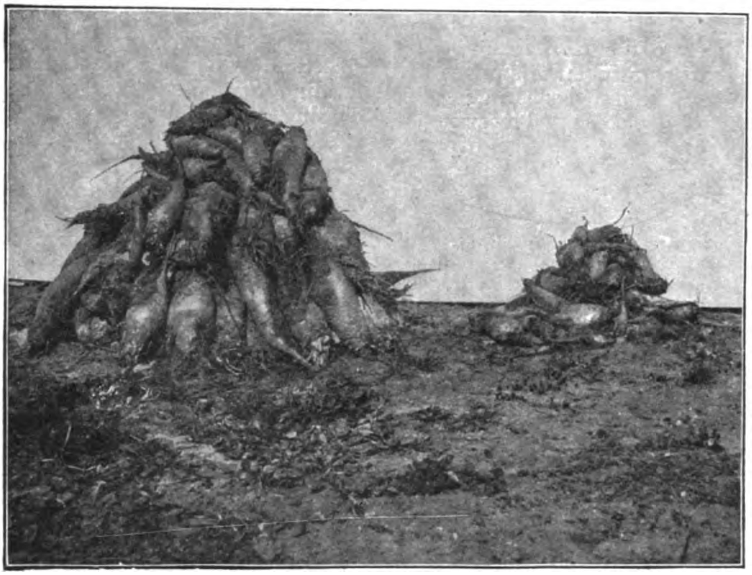


Fig. 130—EFFECT OF LIMING ON ACID LANDS
Pile on left, limed; on right, unlimed

Mangel-Wurzels—These require about the same soil as field beets. They are planted in the spring as soon as the ground can be worked, in rows about 2 feet apart, to permit of horse cultivation, and thinned to 12 or 14 inches in the row. From 4 to 6 pounds of seed are required per acre. It will germinate quicker if soaked in hot water for 6 to 8 hours before planting. The roots grow much larger than field table beets and are coarser grained, though possessing much the same feeding value. They grow partly out of the ground, and are, therefore, easily harvested. The crops should be pulled before heavy frosts set in. Machinery has been devised for this purpose. The leaves should be cut off to within an inch of the crowns and the roots stored in a cool cellar or in pits in the ground, and covered over with straw and earth deep enough to prevent freezing. Some of the better varieties of mangel-wurzels are Red Globe, Tankard, Golden Yellow, Mammoth, etc.

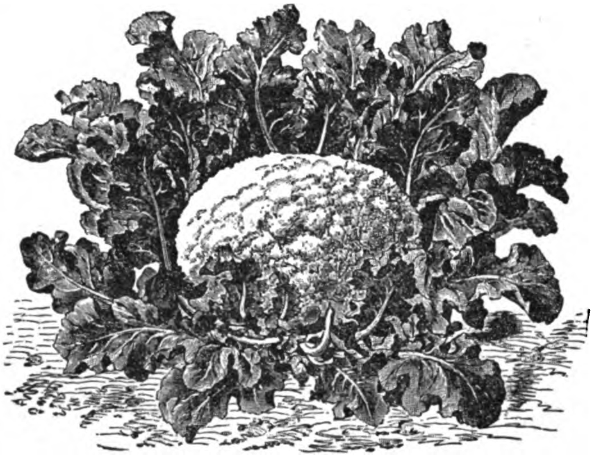


Fig. 131—EARLY WHITE BROCCOLI

Mangels are exceedingly watery, yet the heavy yields obtained per acre (20 to 30 tons) make them stand well as compared with other roots as regards yield of total dry matter. The Cornell Station found that on similar soil the yield in dry matter of sugar beets and mangels was practically the same, but the cost of harvesting the sugar beets was double the cost of harvesting the mangels. The succulent nature of mangels and beets makes them of use primarily for feeding to cows. They also have a good effect when fed to sheep and to pigs, when boiled and mixed with meal. Their chief function in the farm economy is to furnish a palatable, succulent food in winter to supplement the dry hays and grains usually fed, thus keeping the animals in good appetite and form for the more nutritious foods upon which the feeder depends for fattening.

For insects and diseases affecting field and garden beets see under *Sugar Beets.*

BROCCOLI

A strain of late maturing cauliflower, possessing about the same qualities as cauliflower, but found to be a little more hardy than cauliflower at the New York State Station. It is little grown in this country. The best variety is Early White Broccoli. (Fig. 131.) Its cultivation is similar to that of cauliflower.

BRUSSELS SPROUTS

A variety of cabbage which produces numerous small heads in the axil of the leaves along the stalk instead of a terminal head. (Fig. 132.) These heads or "sprouts" are from ¾ to 2 inches in diameter. They are cooked like cabbage or cauliflower and are the most delicately flavored of all the cabbage-like vegetables. Brussels sprouts are cultivated in the same manner as cabbage, but are even more hardy and make their best growth in the cool weather of fall. Only the best strain of seed should be used. If the seed is sown in June the plants will be ready for setting in the field about the last of July or first of August. In the South they may be left out all winter, but in the North the crop should be dug

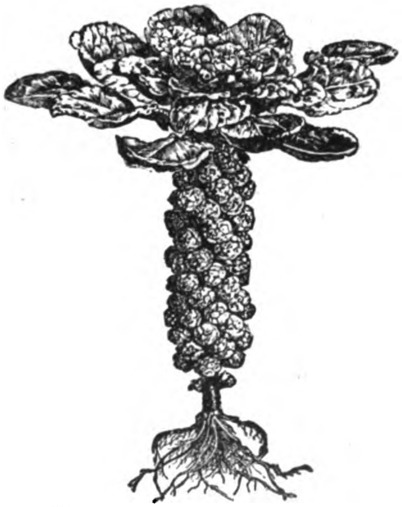


Fig. 132—BRUSSELS SPROUTS

and stored like cabbage. The dwarf or half-dwarf varieties are usually the surest croppers in localities with a short growing season.

For enemies see *Cabbage.*

CABBAGE (*Brassica oleracea* var. *capitata*)

A hardy plant, easy to grow, which will do well on any soil that is rich, well drained and capable of holding a large amount of moisture. A good loam with a gravelly subsoil is generally preferred for cabbage. The crop should be rotated. It succeeds well after sod. All ground for cabbage should be heavily fertilized with well-rotted manure. From 30 to 40 tons per acre is none too much for good yields, and in market gardening sometimes 80 to 100 tons are applied.

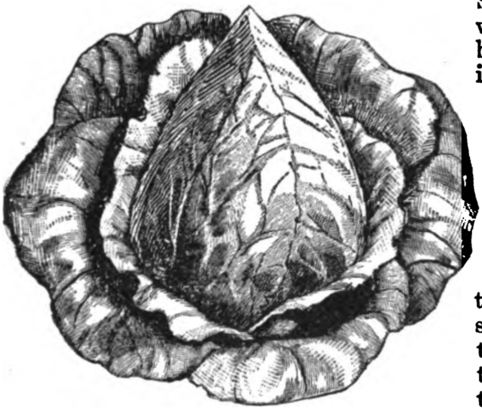


Fig. 133—EARLY JERSEY WAKEFIELD

Planting the Seed—For the early crop start the seed about 5 or 6 weeks before the plants will be needed for setting in the field, in a seedbed in the greenhouse, or sow in a hotbed, or even in a shallow box kept in the kitchen window. Large seed have been found at the Maine Station to produce larger heads than small seed, and at the New York State Station seed from the lower branches of the main stalk gave better results than that taken from terminal pods. Plant the seed in rows ¾ inch apart, putting 4 or 5 seeds to the inch. Cover ¼ inch deep and press the rows down firmly. As soon as the frost is out of the ground in the spring and the weather gets settled, the young plants should be hardened off by gradual exposure to outdoor conditions, and then set in the field in rows 30 inches apart, with the plants 24 inches distant in the rows. This will permit of horse cultivation both ways while the plants are young. Late cabbage is obtained by planting long growing varieties or early or medium varieties late in the season. The seed for late cabbage is started in a seedbed outdoors. Sometimes the seed is sown in hills where the cabbage is to stand in the field, but on account of insects this method is not generally as satisfactory as sowing in a seedbed and transplanting. It requires about ¼ of a pound of seed to produce enough good plants to set out an acre. Where a succession is wanted the seed may be sown every 10 days or 2 weeks up to the middle of June.

Transplanting and Cultivation—In transplanting take the plants out of the seedbed carefully, so as not to break the fine roots, lay in a basket, moisten thoroughly and cover with a wet cloth to prevent the plants from drying out. Choose a cloudy day for transplanting if possible, and if the soil is at all dry make a hole with a dibber or round pointed stick, not too deep, pour in about ¼ of a pint of water, put the plant in the ground up to the first leaves, and pack the wet soil or mud firmly about the roots, putting dry dirt on top to prevent evaporation. Plants seldom ever wilt when thus treated, and

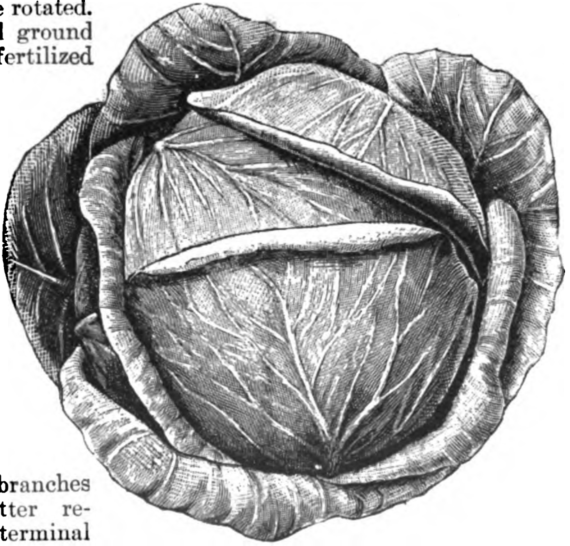


Fig. 134—MARKET GARDENERS PRIVATE STOCK

the method is much to be preferred to planting immediately after a rain.

After setting out, the plants require frequent shallow level cultivation until the crop matures. Too much cultivation cannot be given, and especially after every rain should the ground be thoroughly stirred. A fine-tooth horse cultivator is one of the most satisfactory implements for this purpose. At the Maine Station mulching the plants with straw or similar material in a dry season tended to increase the size of the head. At the Nebraska Station also a straw mulch was found very beneficial for cabbage.

Storing—When cabbage is grown for market it is generally advisable to dispose of as much of the crop as possible in the fall rather than store over winter. Without proper handling cabbage is liable to rot badly. It should never be put in storage when wet, or handled when frozen. Cabbage is in the best condition for storing when it is not fully mature, and while the heads are still a little soft. It keeps well in a cold, damp cellar, stored in shallow bins about 4 feet wide. Another way is to bury the heads in sand or heel them in the cellar. Where the crop is stored out of doors the heads should be placed down in long narrow trenches and covered over with straw and dirt deep enough to prevent serious freezing. The secret of storing cabbage successfully is to keep it cool and moist, but not wet. The stumps should always be left on except when the crop is stored in bins.

Varieties—Early Jersey Wakefield (Fig. 133) is one of the best early market varieties grown. It matures in from 90 to 100 days from the time the seed is sown. It has small pointed heads. Very Early Winningstadt is another early pointed variety with a very solid head. It ranks first in quality and is well suited for the home garden. Of the larger and later sorts, there are a number of strains of the Flat Dutch and Drumhead varieties, nearly all of which are good. Market Gardeners Private Stock (Fig. 134) is one of the best winter varieties.

There is another class of cabbage known as the Savoy. (Fig. 135.) This is the tenderest and most delicately flavored cabbage grown, but does not produce so heavily as the other sorts. The leaves are deep green in color and finely netted and wrinkled. It is more hardy than common cabbage, and makes its best growth in the North from the middle of September to the middle of November. Marvin Savoy, Drumhead Savoy and Perfection Savoy are all good sorts.

Of the red cabbages, the Mammoth Rock Red and Red Dutch are among the best varieties.

Enemies: CLUBROOT (*Plasmodiophora brassicae*) is common on cabbage and related plants, such as turnips, radishes, etc. Affected plants appear sickly and do not form heads. Young plants may be attacked in greenhouses or infection may take place in the field. Swellings appear on the roots, and in some cases the whole root system becomes one mass of diseased tissue. (Fig. 136.) It cannot be treated by spraying. An application of air-slaked lime at the rate of 75 bushels per acre sometimes gives good results. The disease may remain in the soil for a year or more, and rotation of crops is therefore suggested, with destruction of wild plants of the mustard family, on which the fungus may grow. Diseased roots should be destroyed as well as infected seedlings. Only healthy plants should be set out.

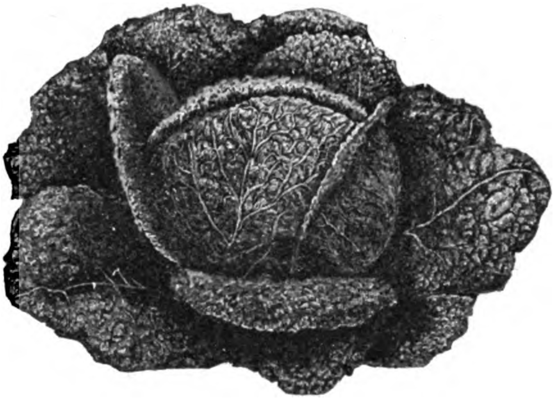


Fig. 135—SAVOY CABBAGE

BLACK ROT (*Pseudomonas campestris*) causes a dwarfing or one-sided development of the heads. Infection by bacteria takes place through the water pores of the leaves, as seen in Fig. 137, the disease having invaded to areas which are left white at BB, with the veins blackened at CC, the germ entered through the water pores at D, and also along the margins of the hole eaten by insects at A. Badly diseased plants may fail to form heads and die. The parasite probably passes the winter in the soil. Cabbage seed should be planted on uninfected ground, preferably where some other crop was cultivated during the previous year. The disease may be spread by the manure of animals which have fed on diseased cabbages. Insects may also help to carry black rot from one plant to another. Cabbage insects should therefore be destroyed. Wild mustard in the vicinity of cabbage fields should be eradicated.

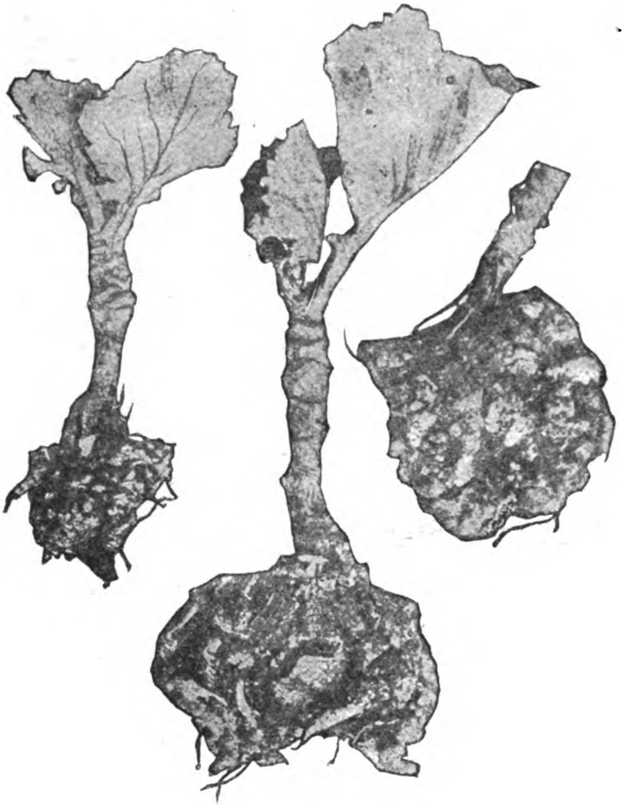


Fig. 136—CLUBROOT OF CABBAGE

DOWNY MILDEW (*Peronospora parasitica*) attacks cabbage and many other wild and cultivated members of the mustard family. Affected parts are distorted and covered with a white mold. For treatment see *Leaf Blight* below.

WHITE RUST (*Cystopus candidus*) has an almost universal distribution and attacks all sorts of cruciferous plants. It causes distortion of affected parts and the formation of a white coating which at first has a polished appearance. It is especially common on shepherd's purse. For treatment see *Leaf Blight* below.

LEAF BLIGHT (*Macrosporium brassicae*) when abundant causes a discoloration of the leaves, which may fall off. The last 3 diseases may be controlled by destroying diseased plants, spraying with Bordeaux mixture and rotation of crops.

HARLEQUIN CABBAGE BUG (*Murgantia histrionica*) is a small insect with bright colors which feeds on cabbage and other plants of the mustard family. The adult is ½ inch long, blue-black, with yellow or orange spots and stripes. The eggs are attached to the under side of the leaves and hatch in a few days into a young bug similar to the adult, except for the absence of wings. This bug is most injurious in the Southern States. Spraying with pure kerosene will destroy the bugs. The eggs may be recognized and destroyed, and the adults may sometimes be captured under piles of rubbish in the early morning. Experiments show that a 20 per cent mechanical mixture of kerosene and water is only slightly injurious to cabbage leaves and will kill nearly all the bugs.

Curculio (*Ceutorhynchus rapae*) is a weevil ⅛ of an inch long, of a black color with yellowish scales. The beetles appear in April and lay their eggs preferably on hedge mustard and other related wild plants. The young feed in the stems and leaf stalks. Apparently cabbage is attacked only when other plants of the mustard family are not to be found. The beetles may be destroyed by spraying with arsenicals. The larvae in the ground may be killed by the use of bisulphid of carbon, and considerable advantage will be derived from the utilization of wild plants as trap crops, which may be thoroughly sprayed for the destruction of weevils.

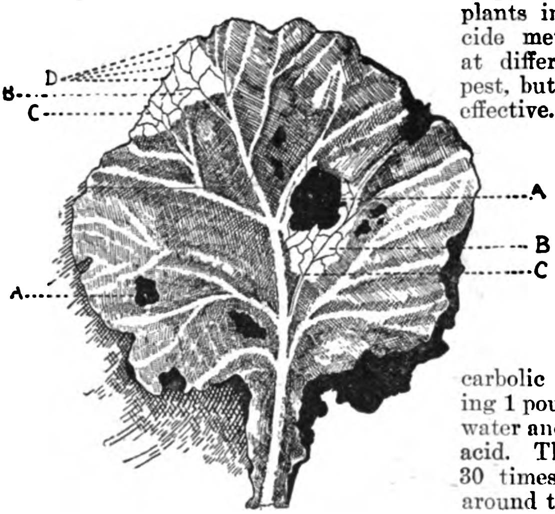


Fig. 137—CABBAGE LEAF IN EARLY STAGES OF ROT

Imported Butterfly (*Pieris rapae*) is about 2 inches across the wings, of a white color, with black tips on the forewings. Underneath the wings are of a pale lemon color. The eggs are laid on the under side of the leaf and hatch in about a week into small larvae, which eat holes in the leaves. When full grown the caterpillars are green, with pale yellow stripes and yellow spots on the sides. There are 2 or 3 broods per year. Pyrethrum in water or mixed with flour, hot water at a temperature of from 140° to 160° F., or kerosene emulsion sprayed over the cabbage plants will destroy these caterpillars. Paris green or London purple is effective when used dry in the proportion of 1 ounce to 6 pounds of flour or other similar substances.

Southern Butterfly (*Pieris protodice*) differs from the imported butterfly in its coloring. There are 3 black spots on the forewings of the male, and the female has a number of irregular spots on the wings. The treatment is the same as for the imported butterfly.

Root Maggot (*Phorbia brassicae*) is the larva of a dark gray fly, with 3 black stripes on the thorax and 1 black stripe along the abdomen. The full grown maggot is 3-10 of an inch long and of a white color. There are 2 broods per year, or possibly 3. The flies appear in April and soon deposit their eggs. The maggots of the second brood feed on plants in July. More than 70 insecticide methods have been recommended at different times for combating this pest, but only a few of them are really effective. Plants may be protected by covering with fine cheesecloth, but this remedy is practicable only on small areas. Tarred paper placed about the base of the stems prevents the flies from depositing their eggs. Injections of carbon bisulphid in the soil are effective in destroying the maggots, and another good remedy is found in carbolic acid emulsion, made by dissolving 1 pound of soap in a gallon of boiling water and adding a pint of crude carbolic acid. This mixture is then diluted with 30 times its bulk of water and poured around the bases of the plants.

Plusia or Cabbage Looper (Fig. 138) is a night flying moth of dark gray color, with a silver spot in the middle of each forewing. The caterpillar resembles the ordinary cabbage worm, but the head is small and the body increases in size toward the posterior end. The larva is an inch long, of a pale green color, with lighter stripes. The caterpillar may be destroyed by spraying with kerosene emulsion or pyrethrum (1 part to 3 of flour).

Diamond-Back Moth (*Plutella cruciferarum*) is the adult form of a caterpillar of a pale green color, ¼ inch long, which forms a web on cabbage leaves. The species is 3-brooded. It may be destroyed in the same manner as recommended for the imported butterfly.

Garden Web Worm (*Hellula undalis*) when full grown is ½ inch long, of a dull gray color, with 5 distinct brown stripes on the back. The moth is gray in color, with various markings on the forewings. The species is especially injurious in the Southern States. The life history is not thoroughly understood, but the insect may be destroyed by spraying with Paris green (1 pound to 140 gallons of water) as soon as the caterpillars appear. The same species attacks turnips, horse radish and other plants of the mustard family.

Plant Lice—This name is applied to the large group of small bugs which infest all kinds of vegetation in every part of the country. The most common species are soft-bodied green insects with or without wings and with long legs. Nearly all species are of small size. The body is usually pear-shaped and the wings are delicate and transparent. The first pair of wings is considerably larger than the second. Not all species are green, but some are brownish, or nearly black. In the growing season the majority of plant lice in a colony are wingless, and during this time they bring forth living young. At the approach of fall winged or otherwise distinguished forms of plant lice appear and eggs are deposited on the host plants, in which stage the insect passes the winter. Winged forms also appear in some species during the summer and migrate to other plants of the same or different species, thus providing for the distribution of the insect. Plant lice infest the leaves, stems and roots of all sorts of plants. They may produce galls on the leaves or curling of the leaves, and on the roots they give rise to various gall formations, such as those which characterize the attacks of phylloxera on grapes and the woolly aphis on apple roots. Some plant lice are covered with a white or yellow powdery or fibrous secretion, which gives a white color to the leaf or bark to which they are attached. The most important natural enemies of these insects are lady-bird beetles, lace-winged flies, syrphus flies and small birds which feed upon the eggs in winter.

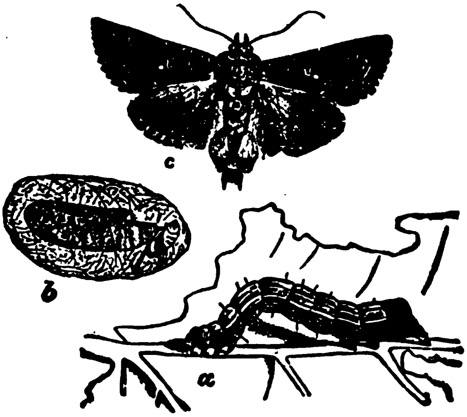


Fig. 138—CABBAGE LOOPER
a, larva; *b*, pupa; *c*, adult

Many plant lice secrete a substance which is known as honeydew, and this is sometimes produced in such quantities that it falls upon the leaves of infested plants, covering them with a glistening, waxy coat. Honeydew is fed upon by bees, ants and wasps. Bees and wasps collect it for food, but are not concerned in the life history of the plant lice. Ants, on the other hand, not only feed upon the honeydew, but attend the plant lice and carry them from place to place, where they may find fresh vegetation for food. Ants attend not only species which infest leaves, but also assist in the distribution of various root-infesting plant lice, carrying them from place to place through burrows in the ground. In general, when ants are seen in large numbers running up and down the trunks of fruit trees, it is safe to assume that such trees are infested with plant lice and that the ants are attending them for the purpose of securing honeydew.

Plant lice in the adult or egg condition are destroyed by the same remedies which are used in the destruction of scale insects. Where especial treatment becomes necessary on trees which are infested with plant lice and not with scale insects, the plant lice may be destroyed by spraying with kerosene emulsion, decoction of quassia or tobacco, strong soapsuds or whale-oil soap and hot water. Plant lice which live underground upon the roots of plants may be destroyed by means of injections of carbon bisulphid into the soil, saturating the ground with kerosene emulsion, or placing tobacco about the bases of the plants and allowing it to leach through the soil. These methods are especially adapted for combating the woolly aphis of apple trees, the beet root louse and phylloxera on grape vines. The use of carbon bisulphid is the most widespread practice in fighting this last named insect. In France some success has been obtained in painting the stems of grapevines with lysol. This substance is supposed to kill the eggs which are deposited on the bark of the stems. For preventing the attacks of phylloxera stock should be used from resistant varieties of vines. The American species which have been most used on account of their resistant power to phylloxera are *Vitis aestivalis, V. riparia, V. rupestris* and *V. labrusca.*

Cabbage is often attacked by a considerable variety of insects besides those mentioned, including flea beetles, thrips, bollworm and army worm. For bollworm see under *Cotton;* thrips, see under *Onion.*

CARROT (*Daucus carota*)

This hardy root crop is grown both for culinary purposes and for stock feeding. Special varieties have been developed for each purpose. In the wild state the plant is a bad weed and the root is woody and useless. The carrot, though widely known, is not cultivated extensively. The most suitable soil for this crop is a deep, mellow, rich loam as free from weed seed as possible, and put into a fine condition by frequent working with harrow and cultivator.

Culture—For the early crop sow the seed as early in spring as the ground can be worked in rows 10 to 12 inches apart if hand cultivated, and 18 to 24 inches if cultivated with a horse. About 2 pounds of seed are required per acre. Cover the seed about 1 inch deep. It is advisable to mix in a few radish seed to help locate the rows, since carrot seed germinates slowly, and cultivation to keep down weeds is frequently necessary before the young carrots make their appearance. When the plants are well up they should be thinned to stand 2 to 3 inches apart in the row. Frequent shallow cultivation should be given with some light implement throughout the season. Late varieties for stock may be sown the latter part of May or as late as the middle of June in the Northern States. The plant makes its best growth in the cool weather of fall.

The crop is harvested usually by hand pulling and topping. The work of pulling is often facilitated by running a plow alongside the rows to loosen them. Where the half-long varieties are grown they can frequently be plowed out. From 200 to 300 bushels per acre is a good yield. The roots may be stored in pits or the cellar like potatoes. There is a considerable amount of hand labor in the culture of carrots, which makes their growth relatively expensive.

Use—Besides the use of carrots as a table vegetable they form a favorite succulent food for horses and dairy cows. Foreign experiments show that for stock feeding purposes carrots are about equal to other roots. The Agricultural Experiment Stations in this country have reported but few experiments with this crop as a stock food. Except for the purpose of variety in the diet it will probably be economy to grow other larger yielding root crops, like mangels and rutabagas. For the composition of carrots see *Appendix.*

Varieties—For table use the small half-long varieties are chiefly grown. Of these Danvers, Oxheart and Half-Long Scarlet are good varieties. Carrots are forced to a limited extent. French Forcing and Extra Forcing are very suitable for this purpose. White Belgian and Long Orange are good stock varieties. Typical forms are seen in Fig. 139, (1) representing Early Fruit Forcing, (2) Early Horn and (3) Long Orange.

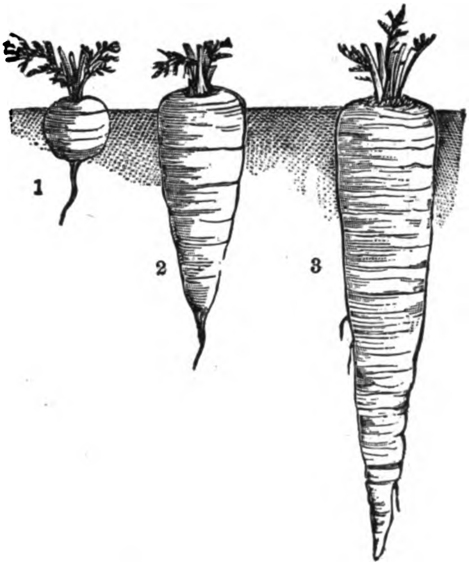


Fig. 139—TYPES OF CARROTS

Enemies: Rot (*Phoma sanguinolenta*) appears as sunken spots on the roots. As the fungus extends into the stem similar pits are formed above ground. The disease is to be recognized by the presence of long red strings of spores on the stem. Diseased carrots should not be stored with healthy ones, since the disease may spread by contact. No seed is produced on plants grown from affected roots.

Leaf Spot—See under *Celery*.

Bacterial Rot (*Bacillus carotovorus*) causes a rapidly progressing soft decay, which begins at the crown and penetrates into the interior. The affected part turns brown and the boundary between diseased and healthy tissue is very sharp. The disease affects also turnips, parsnips, radishes, salsify and other garden vegetables, and may cause great damage after the roots are stored. Rotation of crops should be followed, and the manure from stock which has fed on diseased carrots should not be used on ground where roots are to be planted. Roots should be thoroughly dried in sunlight before storing and the storeroom should be kept at a low temperature.

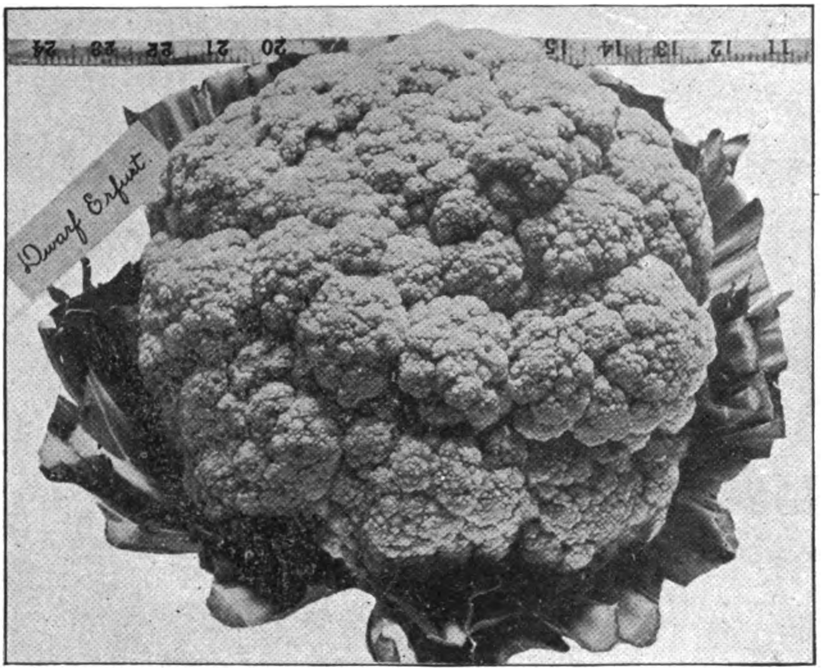


Fig. 140—EARLY DWARF ERFURT CAULIFLOWER
(Fla. Expt. Sta.)

Carrot Fly (*Psila rosae*) is of a shining black color with yellow legs and about ¼ of an inch long. The maggots are transparent yellow and bore in all directions through the roots, in which they leave brown burrows. Kerosene emulsion, 1 part to 10 parts of water, may be sprayed along the rows, or sand moistened with kerosene may be applied to the rows. Application should be made once a week in June. Rotation of crops is also desirable. Carrots are also attacked by plant lice and blister beetles.

CAULIFLOWER (*Brassica oleracea* var. *botrytis*)

This belongs to the cabbage family, but is much more difficult to grow than cabbage. It requires a cool, moist season for its best growth, a constant supply of soil moisture and a rich loamy soil heavily fertilized. The crop grows especially well on Long Island and some of the Northern seaboard States, in some localities about the Great Lakes and in many other favorable locations throughout the country. Often success is obtained only with early and late varieties, since the plant will not thrive in the hot, dry weather of midsummer.

The young plants are started and handled like cabbage. Only the very best strain of seed should be used, and this is usually expensive. Thorough and frequent shallow cultivation is essential. When the heads begin to form the leaves should be brought together and tied over the head to blanch them, otherwise the heads will assume a brown color and have a lower market value.

The most commonly grown variety of cauliflower is the Early Dwarf Erfurt

(Fig. 140), or selected strains of it. Snowball is a good variety for either early or late crops or for forcing under glass.

For enemies see *Cabbage.*

CELERIAC

This is a form of celery in which the root rather than the stalk is the edible portion. It is enlarged like that of the turnip, as seen in Fig. 141, and is used either as a salad or a cooked vegetable. The seed is sown and the crop is cared for in the same manner as celery, except that blanching is not required. The plants do best when transplanted. They should stand 6 to 8 inches apart in the row, and the rows be spaced far enough apart to admit of easy cultivation. The roots may be stored and kept over winter like turnips.

For culture and enemies see *Celery.*

CELERY (*Apium graveolens*)

This is a hardy plant grown in nearly all parts of the country for its leaf stalks. These are blanched and eaten raw with salt, or cut up into salads and soups. Celery grows best on fertile, deep, loose soils which are well drained. Thoroughly reclaimed swamp lands give the heaviest yields of celery and are most in favor with celery growers, though the best quality of celery is grown on uplands.

Early Celery—For the early crop in the Northern States the seed should be sown in February or March in shallow boxes filled with loam and kept in the greenhouse, hotbed, or even the kitchen window. The seed are scattered broadcast and a little sand sifted over them. One ounce of seed will produce from 3000 to 5000 plants. The seed germinates slowly, requiring from 12 to 14 days. During this time the soil should be kept moderately moist. As soon as the plants are large enough they should be pricked out into other boxes or into a hotbed, putting them an inch apart in rows 3 inches apart at the first transplanting, and 2 inches apart in rows 4 inches apart if a second transplanting is made. In pricking out shear or pinch off a portion of the tops and cut back the roots to induce a stocky growth. The plants should be hardened off and set in the field as soon as the weather permits, which will be some time in May. Set the plants in rows about 4 feet apart and 6 to 8 inches distant in the row. The same care in setting will be required as for cabbage plants. (See *Cabbage.*) During the season they will require thorough shallow cultivation. The stalks may be blanched by setting a tile over each plant, wrapping it with paper (Fig. 142), or setting up boards along the sides of the rows to exclude the light. Banking the rows with earth is not generally practiced with early celery, since the hot weather of summer usually induces rot. The so-called self-blanching varieties of celery, as Paris Golden, are the ones best adapted for the early crop.

Late Celery—The main crop of celery is grown in the fall. Seed for this crop should be sown in a thoroughly pulverized seedbed outdoors in shallow rows about 8 inches apart and the rows firmed down with a hoe. In the South the North Carolina Experiment Station recommends for the seedbed a moist border shaded from the south sun by a board fence. The seedbed must be kept moist at all times. Sometimes this is accomplished by putting old bagging over the bed and watering the bed through this. As the seed begin to sprout the bagging is propped up over the plats on stakes until the plants are well rooted, when it is removed altogether. A lath screen is sometimes used for the same purpose. When the plants are about 2 inches high they should be thinned to stand 2 inches apart and the tops sheared off to induce stockiness. Prof. Massey of the North Carolina Station considers it essential in that State to transplant the plants at

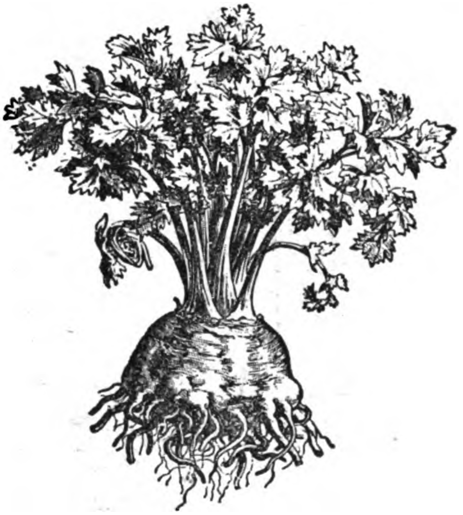


Fig. 141—CELERIAC

least once before setting in the field. This is done when the plants are about 2 inches high. The tap root is nipped off to an inch long, the tops sheared off and the plants set about 2 inches apart in rows wide enough apart to permit hoeing. The transplanting is believed to produce more robust plants for field setting.

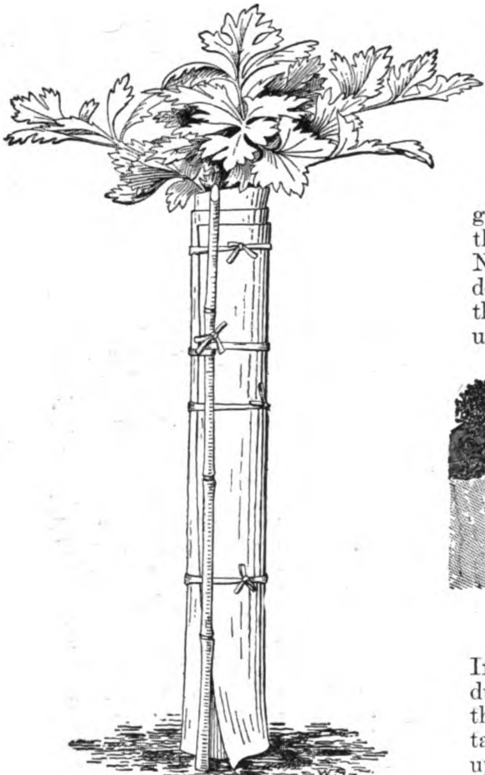


Fig. 142—PAPER WRAPPER FOR BLANCHING CELERY

Late large growing varieties of celery are set out in the North usually in July in rows 5 feet apart and 8 inches distant in the row, and given thorough shallow cultivation. When the plants are about 10 inches high the earth should be drawn up with a hoe and packed around each plant so that it will grow in a close, compact bunch, as shown in Fig. 143. This is called "handling" the celery. As the plants continue to grow more earth is drawn up around them until only the tips of the leaves are to be seen, as shown in Fig. 144. The earth excludes the light and thus blanches the celery, making it brittle and giving it a good flavor. Sometimes boards are used to blanch celery. These are leaned against the plants on either side of the row and the top edges held together by wire hooks, cleats or other means, as shown in Fig. 145.

At the Pennsylvania Experiment Station it was found that celery blanched with boards was ready for market earlier than when blanched with soil, but the quality was poorer, the stalks being long, slender, pithy and bitter, while the earth-blanched stalks, though later, were large, crisp and tender.

Celery in the North intended for winter use is earthed in the fall sufficiently to give the stalks a compact, upright growth, and is then left in the field until the latter part of October or first of November. The crop withstands a few degrees of frost without injury. It is then stored for blanching and winter use either in trenches or in a cool cellar.

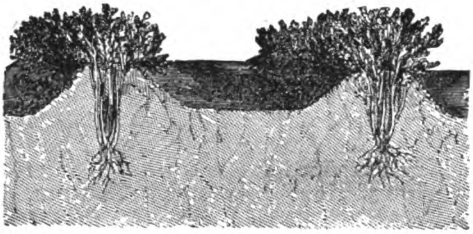


Fig. 143—CELERY AFTER HANDLING

If stored in trenches outdoors these are dug 8 to 10 inches wide, and as deep as the celery is tall. The celery should be taken up with the roots on and packed upright in the trenches, the roots being covered with soil. Soil is not necessary between the plants. Thus treated, the plants start into growth, and this growth blanches the stalks. As cold weather comes on the tops are covered with straw or other loose material and soil heaped on to protect the plants from severe freezing. The illustration (Fig. 146) shows a method of using boards to protect celery packed in

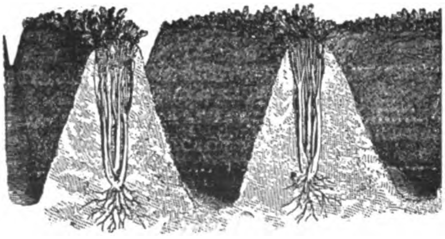


Fig. 144—CELERY EARTHED UP

trenches, which has given good results at the Arkansas Station.

The New Celery Culture—Within recent years what is known as the "new celery culture" has come into use. The principle involved is to grow the celery plants so close together that they will exclude the light from the stalks and thus blanch themselves. By this method the plants are set 8 inches distant in rows 12 inches apart. The so-called self-blanching varieties of celery are used for this purpose, and it is found necessary to board or bank up only the outside rows. This greatly reduces the work of blanching, but when the crop is thus grown the amount of fertilizer and water required by the plants is enormously increased. The failure on the part of many growers to recognize this fact accounts for many of the unfavorable results reported by those who have not succeeded with the new culture.

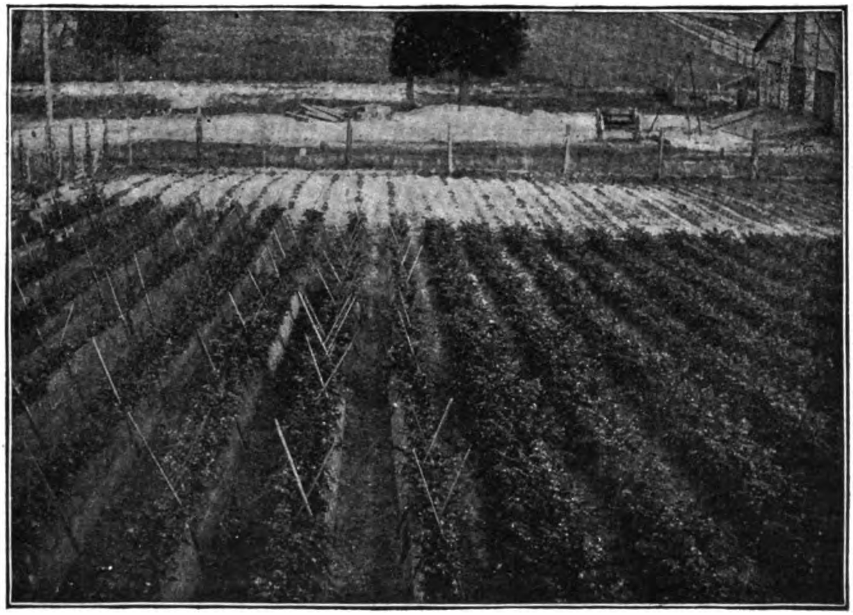


Fig. 145—GROWING CELERY IN WINTER IN FLORIDA
(U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

Fertilizers—The fertilizers most essential in the culture of celery are nitrogen and potash. These are best furnished the plants in well-rotted barnyard manure and unleached wood ashes. The ground cannot be made too rich in these elements for celery. Where they are scarce they should be placed in the bottoms of the rows before the plants are set and thoroughly mixed with the soil. If the plants have started into growth, and, according to their appearance, require more fertilizers, a furrow may be plowed on both sides of the rows and fertilizers worked in.

Irrigation—Celery requires an abundance of water for its best growth, and favorable results with irrigation have been reported at a number of experiment stations. Surface irrigation of celery at the New Jersey Station more than doubled the yield of crop and increased its market value 8 times. Celery irrigated 4 times at the South Dakota Station, with a total of 8 inches of water, developed bunches 4 inches in diameter and 30 inches long. The stalks were crisp and tender and of good quality. Subirrigation through 2-inch drain tiles gave good results at the Michigan Station.

Varieties—Paris Golden or Golden Self-Blanching, White Plume and Giant Pascal are popular varieties which have been reported favorably upon by nearly all of the experiment stations. Paris Golden never has the strong, bitter flavor sometimes present in White Plume. White Plume seems to be more resistant to the bacterial disease than Paris Golden. Both are summer and fall varieties or may be planted for winter use. Giant Pascal is one of the largest varieties grown. For further notes on varieties see R. I. Expt. Sta. Bul. 44. Farmers' Bul. 148 (U. S. Dept. Agr.) contains complete cultural directions for celery. See also "Celery for Profit," by T. Greiner.

Enemies: LEAF BLIGHT (*Cercospora apii*) forms numerous pale spots on the leaves. The spots increase in size and often nearly cover the leaf. The leaves turn yellow and die unless the disease is checked by dry weather. According to some writers, however, the disease is most injurious in dry weather. The difference of opinion on this point is perhaps due to a confusion of several species of fungi. The disease may be easily controlled by the use of fungicides. (See *Spraying.*)

LEAF SPOT (*Phyllosticta apii*) may be distinguished from leaf blight by its brown, instead of light colored, spots, which are few in number and of large size. The affected portions of the leaves remain green. For controlling the disease early spraying with standard fungicides is recommended. (See *Spraying.*)

BLIGHT (*Septoria apii*) causes affected leaves to become wholly brown, with small black specks over the surface. All the foliage of affected plants may become diseased, and all parts of the plant except the roots are attacked. The disease is most injurious in seedbeds and is often spread by means of the seed. Only clean seed should be planted and the young plants should be sprayed with fungicides. Either Bordeaux mixture or ammoniacal copper carbonate may be used. Spraying should begin while the plants are in the seedbed and should be repeated at intervals of 10 days until cool weather appears. Shading checks the disease to a slight extent.

RUST (*Puccinia bullata*) occurs on a great variety of plants of the parsley family. It appears in the form of small brown warts on the leaves. Diseased leaves should be picked off and burned and the plants should be sprayed with dilute Bordeaux mixture.

A BACTERIAL DISEASE is sometimes injurious, especially to the Golden Plume variety. The leaves become blotched with brown, watery spots. The disease may spread rapidly in the stalks if they are kept submerged in impure water. Affected plants may be sprayed as for blight.

CELERY CATERPILLAR (*Papilio asterias*) is the larva of a butterfly of a general black color with yellow and blue spots on the wings. The eggs are deposited on celery, parsnip, parsley and carrot. The full-grown caterpillar is pale green, with black and white marks, and is 1½ inches long. Hellebore or pyrethrum may be used for killing these caterpillars. Celery is also attacked by the cabbage plusia, leaf miners, tarnished plant bug, etc., but not often in a serious manner.

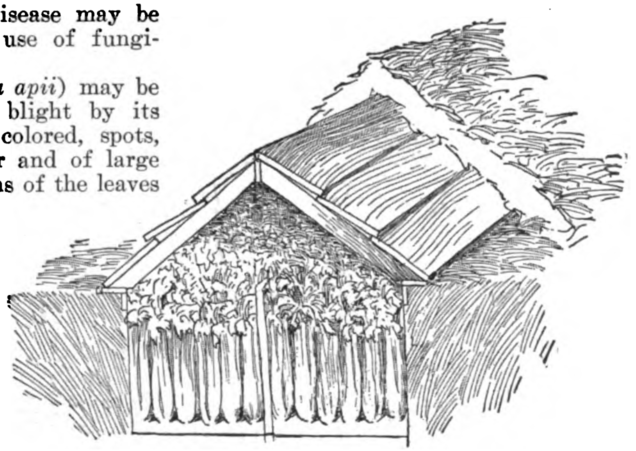


Fig. 146—CELERY PACKED IN TRENCHES

CHARD (*Beta vulgaris* var.)

This is a form of the garden beet, shown in Fig. 147, in which the midrib of the leaves is cooked and eaten as a pot herb, rather than the root. It is known also as sea-kale beet and Swiss chard. It is of easy culture. The seed may be sown in good garden soil as early in spring as the garden can be worked, in shallow drills 12 to 16 inches apart, and cultivated like beets. The whole top of the plant is tender and succulent and may be used for greens, or the broad, thickened white midrib of the leaves alone used like asparagus as a pot herb. The midribs and tops may be gathered from midsummer to late fall and form a very desirable addition to the table. Late grown plants are generally free from blight. Good crops can be secured in ordinary soil from seeding as late as August 1.

COLLARD (*Brassica oleracea* var. *acephala*)

A kind of cabbage growing 2 to 3 feet high which does not make a hard head. The central leaves often form a loose rosette. These are tender and are used as a pot herb like kale. The Georgia collard is widely known and much grown in the South for Southern markets. In the North, where heading cabbages are raised, collards are little grown and not highly prized. Young cabbage plants are frequently eaten as greens under the name of collard. Collard seed is started under glass or sown in beds in the open, and the plants handled and cultivated like cabbage plants. In the field the plants should be set in rows 3 to 4 feet apart and 3 feet distant in the row. A single head of Georgia collard is seen in Fig. 148.

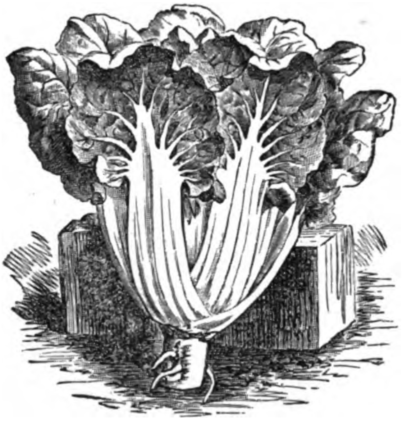


Fig. 147—SWISS CHARD

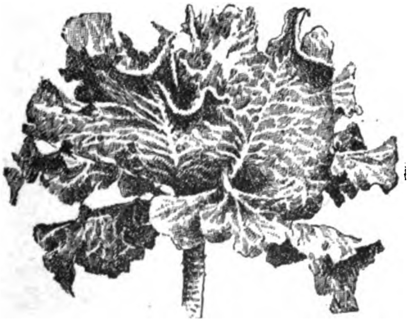


Fig. 148—GEORGIA COLLARD

CORN SALAD (*Valerianella olitoria*)

This salad plant (Fig. 149) is also known as lambs' lettuce, fetticus and vetticost. It may be sown in the spring at the time and in the same manner as lettuce, or handled in the fall like spinach for early spring use. It requires 60 to 65 days of good growing weather to mature. The plant is sometimes used as a pot herb, being prepared and eaten like spinach, but is usually eaten green as a salad. It is considered valuable chiefly as furnishing a diversity and a succession with mustard and cress, with which it is sometimes mixed. It is less crisp and milder in flavor than cress. It is easily grown and has no especial enemies.

CRESS

There are many kinds of cress, all characterized by a more or less pungent taste. They are used in salads and for garnishing dishes. The principal cress grown in this country is water cress (*Nasturtium officinale*). This is grown in almost any ditch, shallow stream or moist earth, and often under benches in greenhouses. It is a perennial and is propagated by scattering either seeds or freshly cut stems where the plants are wanted to grow.

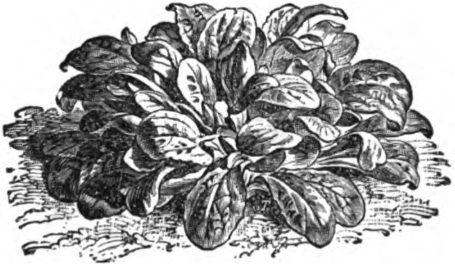


Fig. 149—CORN SALAD

The common garden cress (*Lepidium sativum*) (Fig. 150), or, as it is often called, pepper grass, should be sown thickly in drills every few days if a succession is wanted. It is less pungent than water cress. A winter supply can be had by growing in flower pots or boxes kept in a warm place.

Upland cress (*Barbarea vulgaris*) is similar in character and appearance to water cress. It is a biennial and easily grown from seed.

CUCUMBER (*Cucumis sativus*)

A trailing annual plant, the fruit of which is used for pickling, as a relish and in salads. It is sensitive to frost and requires for its best growth a rich, warm sandy loam. Good corn land is suitable for cucumbers.

Planting and Cultivating—The seed should not be planted in spring until the ground is warm and all danger from frost is past. This in the North will be between the middle and last of May. The crop may be planted even as late as the latter part of June. Prepare the ground thoroughly as for corn and mark out in rows 5 to 6 feet apart each way. From 10 to 12 seed should be planted at the intersections in hills a foot across, covered about 1 inch deep, and the soil well pressed down. On small areas and in garden culture it is usual to place a shovelful or two of well-rotted manure or compost under each hill, covering the manure a couple inches deep with earth before planting the seed. On poor soils the addition of the manure to each hill is especially desirable. Keep the ground cultivated between the hills both ways and loosen the soil about the plants after each rain. After the plants are well up and serious danger from insect pests is past thin out the number in each hill to the 3 most vigorous.

Fig. 150—GARDEN CRESS

Harvesting—Cucumbers are used in the green state. For table use and market they should be gathered when full grown but still green; for pickling the vines must be picked over at least every other morning as long as they are wanted for green cucumbers. Cucumbers 3 to 4 inches in length are generally chosen for pickles. No cucumber should be allowed to ripen seed, for with the ripening of seed the vines begin to die, while, if the cucumbers are kept picked off, the vines continue in bearing a long time.

A good average yield is 100 bushels of cucumbers per acre, though 300 to 500 bushels are sometimes obtained under favorable conditions of soil and weather.

Varieties—For table use and market the various strains of White Spine (Fig. 151) are among the best; Cool and Crisp, Boston Pickling and Green Prolific are good pickling sorts. Early Russian and Cool and Crisp are very early varieties. Cucumbers are frequently forced in the greenhouse. For this purpose the English Frame cucumbers are among the best sorts. White Spine is one of the most productive forcing varieties.

Early Culture — Where very early cucumbers are desired the seed is frequently started in tin cans, strawberry boxes, flower pots or on inverted sods in the greenhouse or hotbed and the plants set out in the field when the weather gets warm enough. The cucumber does not transplant readily, therefore the seed is sown in some receptacle that may be taken to the field and the plants set out without disturbing the roots. If sods are used 4 or 5 seed are placed on inverted pieces about 6 inches square and covered with rich soil. The roots penetrate the sod and the whole is easily removed to the field. The after cultivation is the same as noted above.

Pickling — In pickling cucumbers about 7 pounds of salt are required to preserve a bushel of pickles. The brine should be just sufficient to cover all the cucumbers, which should be kept down beneath the brine by a weighted cover. Pickles are easily kept until the following spring by this method. When wanted for use they are first soaked out in fresh water and then placed in vinegar.

Enemies: DAMPING OFF (*Pythium debaryanum*) attacks seedlings in the forcing bench and hotbed. The stem decays near the surface of the ground and the plant falls over. Diseased plants should be promptly removed and burned. In badly infected hothouses all the soil should be removed and the walls and benches treated with whitewash before refilling with fresh earth.

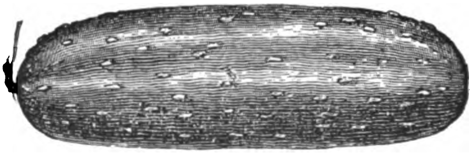


Fig. 151—WHITE SPINE CUCUMBER

Leaf Glaze is characterized by the stunted appearance of affected plants. The fruits are deformed and the leaves turn yellow and die. A white polished film is seen on the under side of diseased leaves. Fungicides have not been found very effective against this disease.

Powdery Mildew (*Erysiphe cichoracearum*) affects all parts of the vines and is most common in greenhouses. The fungus grows on the surface of the leaves, covering them with a white powder. The stems are affected in the same manner. The disease may be checked by spraying with the standard fungicides in a diluted form. (See *Spraying.*)

Downy Mildew (*Plasmopara cubensis*) appears as yellow irregular spots on the leaves, which are soon entirely covered and shrivel up. In cool weather the disease progresses slowly. The old leaves are attacked first. The fungus lives also on pumpkin, squash, watermelon, etc. This disease may be completely controlled by spraying every 10 days with Bordeaux mixture (1-8 formula). Experiments in shading the plants showed that little is to be expected from this practice.

Scab (*Cladosporium cucumerinum*) appears as semi-transparent watery spots in the leaves. The disease makes rapid progress and the foliage soon wilts and decays. Plants should be sprayed with a standard insecticide as soon as the trouble appears.

Stem Rot (*Sclerotinia libertiana*) first appears as dense white mats of fungous felt at the joints of the stem. The stems soon shrink and turn yellow. White fungous threads are found inside of diseased stems and hard black bodies near the joints. Infection is spread by means of these bodies, and by promptly removing and destroying affected plants the disease may be checked.

Wilt—See under *Cotton.*

Striped Cucumber Beetle (*Diabrotica vittata*) is 2-5 of an inch long, of a yellow color, with black head and 3 black stripes on the wing covers. The beetle passes the winter in the adult condition and appearing early in the spring attacks the foliage of cucumbers and related plants. The eggs are dropped in various places on the ground, and the grubs feed on the vines and fruit wherever these come in contact with the soil. They are especially injurious to cantaloupes. Many remedies have been proposed for this insect, but perhaps no single one can be relied upon when the insect appears in great numbers. The application of arsenical poisons to the foliage is somewhat unsatisfactory on account of the fact that the foliage is readily injured by these poisons. There are no remedies for protecting the flowers against the attacks of the beetles or for protecting stems and fruits against the work of the larvae. It is recommended that squashes be planted on the margins of fields earlier than the cucumber, and that the squashes be dusted with green arsenite for the purpose of killing the beetles. The cucumbers should at the same time be sprayed with Bordeaux mixture (1-10 formula). This substance is very distasteful to the beetles, and they therefore leave plants sprayed with it and feed upon some other plants. In the fall squashes or beans may be planted in fields, and as soon as the beetles are found feeding upon them in considerable numbers the plants may be dusted with green arsenite. Covers may be used for protecting the plants with considerable advantage, especially on small areas. The best success is to be expected from planting squash as a trap crop, spraying it with arsenical poisons and spraying the cucumbers at the same time with Bordeaux mixture. In Fig. 152, at *a* is seen the larva, at *b* the bettle magnified.

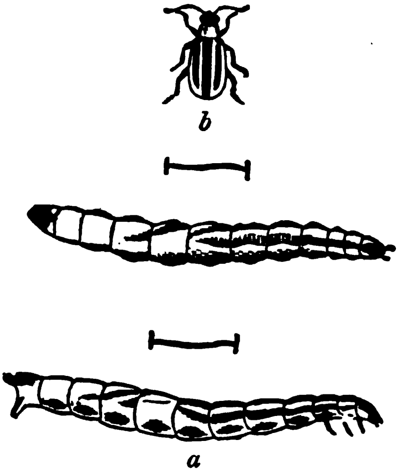


Fig. 152—CUCUMBER BEETLE AND LARVA

Spotted Cucumber Beetle (*D. 12-punctata*) is a small beetle closely resembling in shape the striped cucumber beetle, but readily distinguished from it by the presence of 12 black spots on the back. The general color is yellow. It is especially injurious in the Southern States. The remedial measures are the same as for the striped cucumber beetle.

Melon Aphis—See under *Plant Lice.*

Pickle Worm (*Margaronia nitidalis*) when full grown is somewhat less than an inch long, of a uniform green color, slightly tinged with yellow. (Fig. 153.) The adult moth measures 1¼ inches across the wings, is of a yellow-brown color, with a purple reflection, the forewings being marked with an irregular yellow spot. The larvae feed on squash, cucumber, pumpkins, gourds, watermelons, but show a preference for the squash. It is recommended that squash be planted around cucumber fields and also here and there in the field as a trap crop. These plants may then be examined twice a week and all caterpillars collected and killed. The old vines and rubbish should be raked up and burned. The trap crop should be sprayed with arsenical poisons.

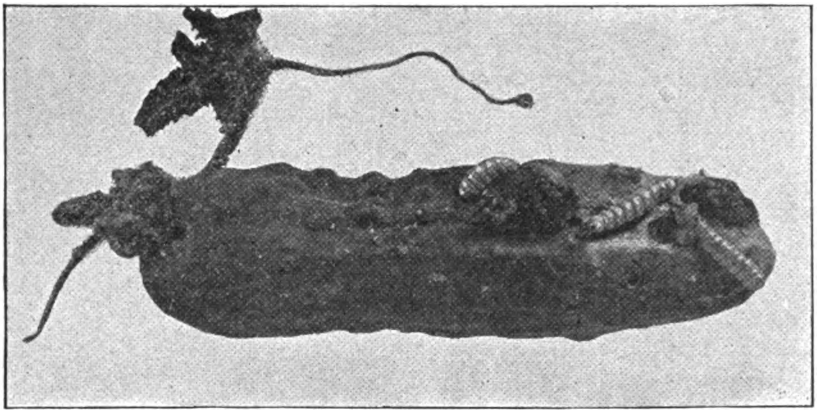


Fig. 153—THE PICKLE WORM AT WORK
(Ga. Expt. Sta.)

Melon Caterpillar (*Margaronia hyalinata*) closely resembles in its habits the pickle worm and attacks the foliage rather frequently. There is no striking difference in the work of these 2 insects when the fruit is attacked. The moth is of a pearly white color, with a border of brown or black. On account of its habit of feeding on the leaves the first brood of caterpillars may be killed by spraying with arsenical poisons. Rotation of crops is also recommended.

Squash Bug and Squash Borer—See under *Squash.*

Four-Lined Leaf Bug—See under *Currant.*

Flea Beetle—See this subject.

CUCURBITS (*Cucurbitaceae*)

This is the general term applied to a large family of plants, including such vegetables as cucumbers, squashes, pumpkins, melons, etc. For the culture and use of these different vegetables see under their common names. The commonly accepted notion that these plants cross with each other when planted together is without foundation. Cucumbers do not spoil muskmelons when these crops are planted together, neither do pumpkins contaminate watermelons. The results of cross-fertilizing experiments at the New York Cornell Station (Bul. 25), Iowa Station (Bul. 19), and Nebraska Station (Rpt. 1899, p. 50), with these plants go to show that if there is any immediate effect whatever of the foreign pollen it is not discernible in the form, color or shape of the fruit or seed. The belief that new or fresh cucumber, squash and melon seed tend to produce plants which run to vine rather than fruit was also found to be erroneous by the New York Cornell Station. (Bul. 15.) The muskmelon was grafted on the watermelon, and both of these on the cucumber by the same station. The staminate flowers usually appear 5 or 6 days earlier than the pistillate flowers on these plants, and are from 6 to 24 times as numerous.

DANDELION (*Taraxacum officinale*)

This is a common weed in many meadows. It is frequently gathered for "greens," and is much prized for this purpose. In Europe and about some of the larger cities of the United States, like Boston, improved varieties of dandelions are grown commercially. The improved forms (Fig. 154) are much larger than the wild plants. The seed of these dandelions are sown in the spring in rows about a foot apart, and the plants thinned to stand a foot apart in the row. The crop is gathered the following fall or spring and marketed like spinach. Sandy loam soil is best suited for this crop. Plants should be partially blanched by placing a covering of boards or boughs over the rows. French Garden and Improved Thick Leaves are good sorts.

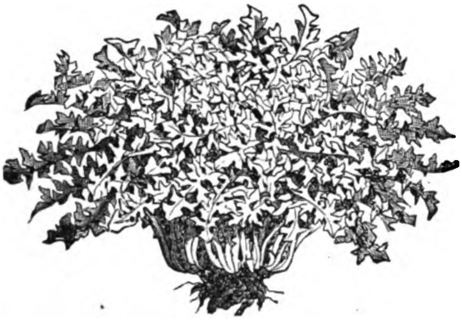


Fig. 154—IMPROVED DANDELION

EGGPLANT (*Solanum melongena*)

This vegetable is grown commercially only in the South, the northern border being New Jersey and Long Island. Farther north the crop is not certain and is grown only to a limited extent for home use. Its culture is similar to that of the tomato, except that it requires a much longer season to mature.

The plants should be started under glass and should be at least 6 or 8 inches high and vigorous when set in the field. Transplanting to the open field should not take place until the soil is warm and all danger from frost is past. In the North this will be from about June 1 to 15. When only a few plants are wanted it will be better to buy them. Ten or 12 plants will be sufficient for a large family. The plants are best handled in 2-inch or 3-inch pots, as they then suffer no check when transplanted to the field. The secret of growing eggplants is to use vigorous, thrifty plants and keep them growing. Any check to growth is exceedingly difficult to overcome and invites failure.

The plants require a warm, sunny exposure and thrive best in a rich, loamy soil that is fairly dry. Manure heavily. Set the larger growing varieties about 3 feet apart each way and the smaller varieties a less distance. Cultivate thoroughly throughout the season. Only the earlier varieties should be grown in the North. The fruits may be used for cooking from the time they are 1-3 grown until maturity.

Of the different varieties Early Dwarf Purple, Early Long Purple and White Chinese are considered best for home use, and New York Improved (Fig. 155), Black Pekin and Early Long Purple for market. (N. Y. Cornell Expt. Sta. Bul. 26.)

Diseases: ANTHRACNOSE (*Gloeosporium melongenea*) appears as a shallow pit on the surface of the fruit, which becomes marked with small pink specks. The standard fungicides will control the disease. (See *Spraying.*)

BROWN ROT—See under *Potato.*

DAMPING OFF—See under *Cucumber.*

FRUIT MOLD (*Botrytis fascicularis*) causes tan-colored blotches on the fruit, with a softening of the tissue and development of a gray felt of fungous threads on the surface. The fruit ultimately rots.

LEAF SPOT (*Phyllosticta hortorum*) is recognized as brown or gray dead patches on the leaves, which are covered with black specks. Shrunken patches also appear on the fruits. The disease may be controlled by rotation of crops, mulching with hay, and repeated applications of Bordeaux mixture.

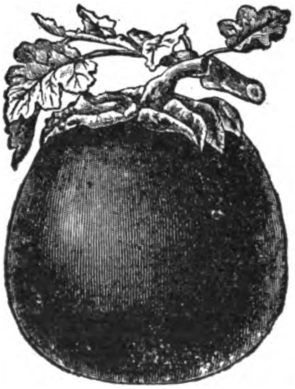


Fig. 155—NEW YORK IMPROVED EGGPLANT

SEEDING STEM BLIGHT (*Phoma solani*) causes a shrinking of the stem near the ground, with death of the tissue and falling over of the stem. Slightly affected plants may live for some time, but make poor growth. The best treatment consists in spraying the soil and bases of the stems with Bordeaux mixture.

Stem Rot (*Nectria ipomoeae*) is to be known by the sickly yellow color of the foliage and by the presence of a white mold on the lower part of the stem. Numerous small pink bodies will be found on the stem at the crown. Diseased plants should be destroyed and rotation of crops followed.

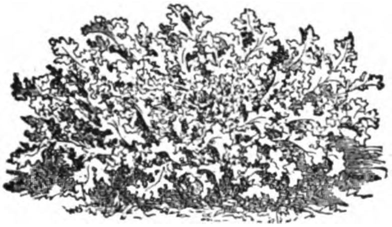


Fig. 156—GREEN CURLED ENDIVE

For insect pests see under *Potato.*

ENDIVE (*Cichorium endivia*)

This is sometimes used as a salad plant, but is more especially valuable for greens, the young tops being used for this purpose. The crop is frequently blanched like celery by tying up the leaves, drawing earth up around the plants, and by other means. The plant requires about 50 days to mature. The Vermont Station states that "endive may be sown early in cold frames or in the open ground like lettuce. Sowings may also be made at any time during the summer, although plants grown in the heat of midsummer have not the best quality. Fall grown plants may be taken up with a good supply of adhering earth and stored in a dry cellar or cold frame for winter use. There are several distinct varieties of endive. Those with comparatively smooth leaves are the larger and coarser. The finely cut and curled varieties (Fig. 156), and more particularly those with naturally whitened leaves, are most attractive and usually most tender." (Vt. Expt. Sta. Bul. 54.)

GARLIC (*Allium sativum*)

A hardy, perennial, bulbous plant (Fig. 157), similar in culture and use to the onion. It is propagated by "cloves," which are similar to onion sets. These should be set early in spring in any good soil 4 to 6 inches apart in drills. The bulbs mature by early fall. They are much stronger than onions and little sought after in this country except by members of the foreign population.

GINSENG (*Panax quinquefolium*)

This plant grows wild in the woods from Canada south to Alabama and west to the Mississippi and the first tier of States beyond. The roots are used as a medicine by the Chinese, and those gathered in this country find their way to that market. The increased price received for the root within recent years has stimulated efforts toward its artificial cultivation. Cultivated intelligently it seems to be as easily grown as other plants. Shade and the right kind of soil are the essentials.

The plant is a perennial herb 6 to 24 inches high. A main stem the size of a lead pencil is sent up from the root each year, which bears at its top from 1 to 4 (usually 3) compound leaves, in the axil of which is borne a flower stalk 2 to 5 inches long. From 12 to 100 bright red berries, much resembling in appearance dogwood berries, are borne on this flower stalk. The root is spindle or carrot-shaped, as seen in Fig. 158, and varies in size from 1/8 inch in diameter to 1 inch or more when 5 or 6 years old. The weight in the latter case may reach an ounce or more.

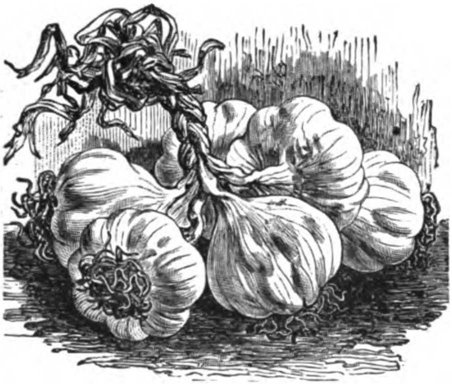


Fig. 157—A BUNCH OF GARLIC

The plant is propagated from seed planted in the fall. The seed gathered in July, if sown in the fall, may germinate the following spring, but as a rule it lies in the ground 18 months before germinating. The germinating power of the seed is destroyed if they are allowed to dry out. It is usual, therefore, to stratify them in moist soil in the fall the same as nuts. The seed should be put in boxes with alternate layers of moist sand and the box buried in the open ground over winter and summer, and the seed planted the fall following.

Plantations of ginseng may be made either in the natural woods or in cultivated ground. In the latter case artificial shade must be provided. In its natural state ginseng develops best on east and north hillsides and generally in dense shade. It prefers a rich soil inclining toward a sandy loam. When plantations are made in the woods the underbrush should be cut out and soil dug up to a depth of 6 inches, removing all surface roots. The Kentucky Station advises that the seed be planted ½ inch to 1 inch deep in rows 1 foot apart and 6 to 8 inches distant in the row. The beds should be about 4 feet across and any length, with a space 2 feet wide between each bed left for convenience in working and harvesting. After planting, a thin layer of leaf mold is spread over the seed, and they are left alone until they come up. The crop requires no other cultivation than the removal of the weeds and the subsequent gathering of the crop.

The roots develop slowly and should not be gathered before they are 5 or 6 years old. They continue to increase in size until about 10 years old, when the main root begins to grow woody and finally sloughs off, leaving a younger root in its place. Nearly every root produces 2 or 3 stem roots, which spring from the rootstock near the crown. If these are carefully removed and transplanted they develop into as good roots as though grown from the seed. This method is frequently employed in starting a plantation from wild roots, and when cultivated plantations are dug over these smaller roots are saved out and transplanted again, and only the larger roots sold.

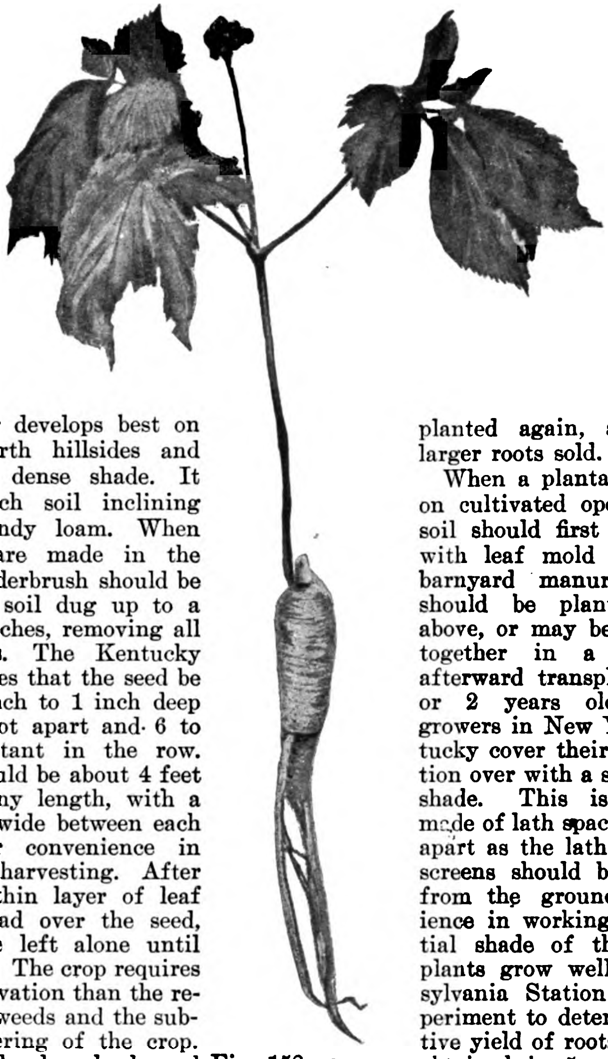


Fig. 158—GINSENG ROOT AND PLANT

When a plantation is started on cultivated open ground the soil should first be made rich with leaf mold or well-rotted barnyard manure. The seed should be planted as noted above, or may be planted close together in a seedbed and afterward transplanted when 1 or 2 years old. Successful growers in New York and Kentucky cover their entire plantation over with a screen to afford shade. This is conveniently made of lath spaced about as far apart as the lath is wide. The screens should be 4 or 5 feet from the ground for convenience in working. In the partial shade of this screen the plants grow well. The Pennsylvania Station made an experiment to determine the relative yield of roots that could be obtained in 5 years from (*a*) seed, (*b*) wild roots gathered from the woods, and (*c*) 2-year-old roots bought from a nursery. The ginseng bed was prepared by adding 3 inches of woods earth to a cultivated soil and spading in 10 inches deep. The roots were set 8 inches apart each way. A lath screen 6 feet high afforded shade. The cultivated plants yielded nearly 5 times as many pounds of marketable roots as the wild roots and 8 times as many as the plants from seed. The total yield of seed also was nearly 10 times greater with the 2-year-old ginseng plants than with either wild roots or seed. The largest of the roots from the nursery reached a weight of 6 ounces at the end of the 5-year period or 9 years from the time the seed was sown. The roots dried away about two-thirds. The dried product from the cultivated roots brought $8.50 per pound and from the wild roots $6 per pound. Ordinarily the price of ginseng is not as high as these figures, the average being from $4.50 to $5 per pound for the dried roots. From the results obtained in the above experiment it is estimated that the 80,000 2-year-old plants necessary to plant an acre of ground would cost $8000 and the lath shade for the same about $650. The yield of dried roots at the end of 5 years would be about 2900 pounds, worth, at $8.50 per pound, $24,650, to say nothing of the seed, which now has a value of $80 to $150 per pound. Northern ginseng seed runs about 8000 to the pound and southern seed 12,000 to 13,000. The fact that it requires 5 to 9 years before a crop can be secured will keep many men from going into the business.

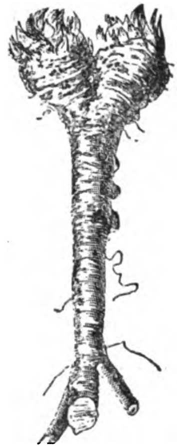


Fig. 159—HORSE RADISH ROOT

One writer states that after 5 years' cultivation he secured from a bed 4½ rods square 106 pounds of dried root valued at $575. The larger the roots are, the more desirable they become and the higher the price paid for them.

Ginseng has no serious diseases or insect pests. Mice are occasionally troublesome. (Ky. Expt. Sta. Bul. 78; Div. of Botany, U. S. Dept. Agr., Bul. 16, rev.; Pa. State Dept. Agr. Bul. 27; Pa. Expt. Sta. Bul. 62; M. G. Kains, "Ginseng, Its Cultivation, Harvesting, etc.," etc.)

GREENHOUSE

This is a general term applied to all glass houses in which plants are grown or kept green, except hotbeds and cold frames. A house for the display of plants is called a conservatory; for the culture of tropical or semi-tropical plants, a hothouse or stove; for growing vegetables and fruits out of season, a forcing house, etc. The principles of greenhouse construction, heating and management are extensive and cannot be treated here in detail; special works on this subject should be consulted. Among the best of these are Taft's "Greenhouse Construction" and "Greenhouse Management," and for the growing of vegetables in winter under glass Bailey's "Forcing Book." The growing of vegetables under glass is fast assuming enormous proportions in the vicinity of the larger cities. Some of the popular crops under glass are lettuce, tomatoes, cucumbers, muskmelons, eggplants, radishes, etc.

HORSE RADISH (*Cochlearia armoracia*)

This plant is grown for its pungent root, which is grated and mixed with vinegar as a relish for meats, oysters, etc. It is a hardy perennial, but in commercial culture is grown as an annual. It is frequently seen in out-of-the-way places on old homesteads, where it grows without attention, furnishing an indifferent supply of branching, woody roots of poor quality. This is not the way to grow horse radish.

The crop grows best on rich cool clay loams. It seldom produces seed. It is propagated commercially by 3-inch to 7-inch cuttings of the small side roots. These are saved from the trimmings when the roots are dug in the fall for market. They are tied up in bundles and preserved over winter like the marketable roots in a cool cellar or pit. The horse radish root makes its best growth in the cool weather of fall, hence there is no hurry in setting the root cuttings out in the spring. They are frequently set in the rows of early cabbage, radishes or beets, and when these crops are removed the ground is given up to the horse radish.

The cuttings are set top end up 2 to 5 inches below the surface of the soil.

They may be set perpendicular, slanting or horizontal, and will give about the same results by all 3 methods. The rows should be 2½ feet apart to admit of horse cultivation and the cuttings 10 to 12 inches distant in the row. The plant will stand considerable abuse, and if the leaves appear above the ground before the other crops are removed they may be cut off 2 or 3 times without injury. After the cabbages or beets are harvested 1 cultivation is usually sufficient before laying the crop by, since the plant grows rapidly and its broad leaves soon cover and shade the ground, keeping down weeds.

The growing roots are of inferior quality and should not be dug at the earliest before September. The later in the fall they are dug the better the quality. For home use the roots may be left in the ground over winter and dug whenever needed, but commercially they are dug in the fall, the side roots trimmed off and saved for next year's planting and the marketable roots stored where they will not dry out, either in a cool cellar, or, better still, in pits. A well-grown marketable root is seen in Fig. 159.

For home use 8 or 10 plants will usually be sufficient for a large family. They may occupy a plat 3 by 6 feet or fill out a row of rhubarb in the garden and treated as a perennial. The roots thus produced will be irregular, unmarketable and of inferior quality, but there is no trouble in growing the crop. More satisfactory results will be obtained by treating the crop as an annual and setting out a few cuttings each spring. The increased value of the crop will more than repay the increased trouble in growing. Horse radish is seldom troubled with insect or fungous pests. (See also Div. of Botany, U. S. Dept. Agr., Cir. 15.)

Enemies: LEAF SPOT (*Septoria armoraciae*) causes the leaves to turn yellow, with the formation of numerous holes. Horse radish is sometimes attacked by leaf blight and leaf mold. If these diseases become so serious as to require treatment they may be checked by Bordeaux mixture.

FLEA BEETLES are often injurious to the leaves. For treatment see *Flea Beetles.*

HOTBED

Low glass-covered frames or boxes in which plants are grown by the aid of artificial heat. By the use of the hotbed many plants may be started considerably in advance of the usual time of seeding outdoors and the earliness of the crops thus greatly advanced. Radishes and lettuce are often grown to maturity in the hotbed before they can be sown outdoors, and cabbage, tomatoes, eggplants, etc., are usually started in hotbeds and transplanted to the open fields when the weather permits.

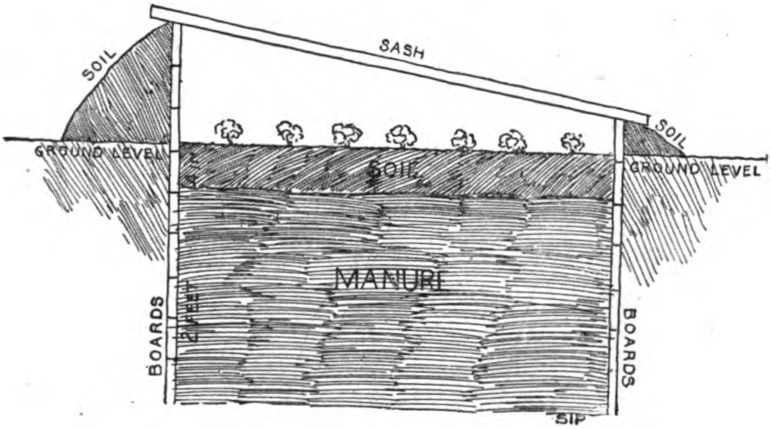


Fig. 160—SUNKEN HOTBED

Hotbed frames are usually made of inch boards. If the boards on the back of the frame are 15 inches wide those in front should be 10 to 12 inches wide. This will give a slant to the sashes, so that water will run off quickly and permit a better utilization of the sun's heat. The frames are usually made 6 feet wide and as long as desirable. However, as the sashes are usually 3 feet wide, the length of the frame should be some multiple of 3. A serviceable bed for farm purposes is 6 feet wide and 12 feet long. In cold weather shutters are put on at night over the glass or some form of mat to better protect the plants.

Fresh horse manure, or sometimes sheep manure, is the material generally employed in heating the hotbed. The manure may be spread on top of the ground and the frame set over it, or a pit may be dug in the frame and the manure placed in the pit. On well-drained ground the latter is perhaps the more usual way. The fresh manure is first gathered in a pile under shelter. It soon begins to ferment and heat; or if it should be slow about heating, fermentation may be started by pouring a pail or so of hot water on the center of the heap. After the manure begins to heat well it should be forked over and the outer portion of the heap thrown on the inside of the pile. The clear horse manure heats too violently and should therefore be mixed with about its own bulk of leaves or fine straw. When it has heated up the second time it is ready to put in the hotbed.

In the more Northern States when the bed is started the middle of March a layer of manure 18 to 24 or even 30 inches deep should be put into the frame and well trampled down. Farther south, and when the weather is warmer, a layer 8 to 10 inches thick may be sufficient. The manure should extend beyond the dimensions of the frame to more thoroughly keep out the cold, and the outside of the frame should be banked up level with the manure on all sides. As a further protection from cold the hotbed should be made on a southerly exposure protected from the north by buildings, windbreak or a high, tight board fence.

The manure in the hotbed should be covered 4 to 6 inches deep with good rich sandy soil mixed with compost. There should be a space of 6 to 10 inches between the earth and the sash on the lower side, as seen in Fig. 160. The manure in the hotbed will heat violently for a few days. When the temperature of the soil begins to fall below 90° F., as indicated by a thermometer, seed may be sown. The manure will continue to furnish heat for 6 or 7 weeks before it becomes exhausted.

Considerable attention is necessary in the care of the hotbed that the plants do not grow spindling and soft. On warm days the sash at the upper end should be raised 1 to 2 inches, and if the wind is not blowing and the sun shines even more air should be given. As warmer weather approaches more and more air should be given the plants, until the sashes are

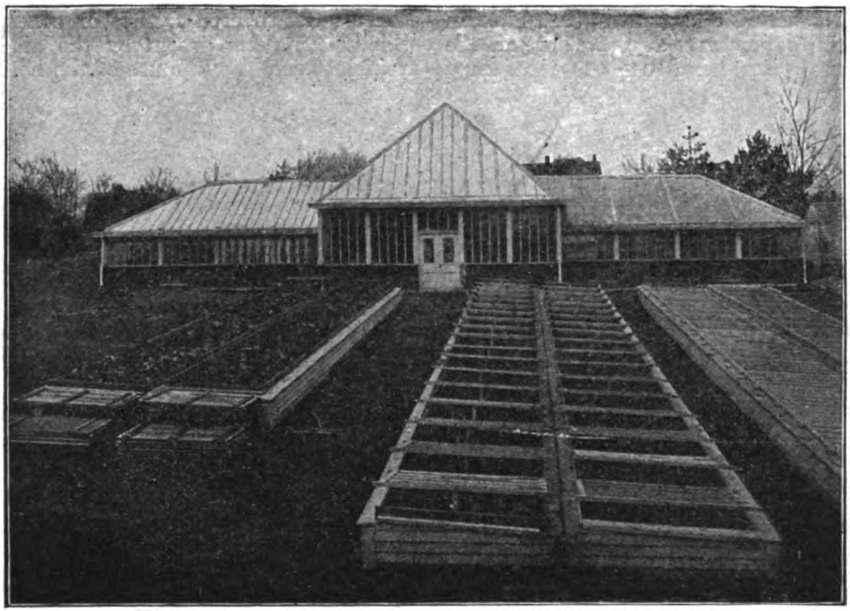


Fig. 161—HOTBEDS IN CONNECTION WITH GREENHOUSE
(Mo. Expt. Sta.)

finally removed entirely during the daytime and left off at night when danger from frost is past. A range of hotbeds in connection with a greenhouse is seen in Fig. 161.

Cold Frame—A cold frame is made exactly like a hotbed, except that no manure is used for heating. The only heat used is that obtained from the sun, which is retained by the glass. Plants can be started in a cold frame sooner than they can be seeded outdoors, but not so early as in a hotbed.

KALE or BORECOLE (*Brassica oleracea acephala*)

This is a cabbage-like plant which does not form a head, but only a thick crown of leaves. (Fig. 162.) It is used as a vegetable for greens in early spring and late fall. The leaves are often finely cut or crinkled and the leaf stems fleshy. The crop is very hardy, and in the South as far north as Virginia remains outdoors all winter without injury. Kale leaves, which in the early fall are tough, become more tender and crisp after a few frosts.

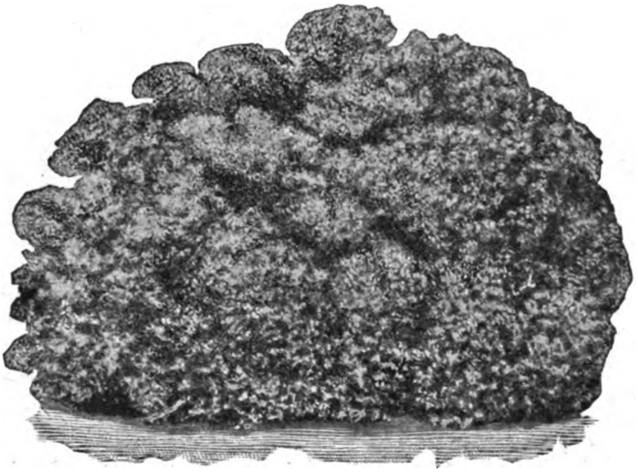


Fig. 162—KALE OR BORECOLE

Kale requires the same kind of soil as cabbage. The seed should be sown in drills 18 inches to 2 feet apart and the plants thinned to stand 8 to 20 inches apart, according to the variety. The plants require the same cultivation throughout the season as cabbage. In the vicinity of Norfolk, Va., where vast quantities of kale are grown for Northern markets, and also farther south, the crop is planted about the first of September. The seed is sown on ridges made by plowing up one or more rows. A heavy growth is made during the fall months. The crop is harvested at any time during the winter or spring when the market demand is good. If handled when frozen it should first be thawed out in cold water. Kale is especially valuable only very early or very late in the season when other kinds of greens are scarce.

For enemies see *Cabbage.*

KOHLRABI (*Brassica oleracea caulorapa*)

This plant belongs to the cabbage family. In Europe and some portions of Canada it is grown as a stock food as well as a vegetable. In the United States it is cultivated, but only to a limited extent and only as a vegetable. Rape makes a better stock food. The edible portion of the plant is the enlarged stem just above the ground. (Fig. 163.) It is cooked, eaten and tastes like turnips, but surpasses turnips in delicate flavor, and is more desirable for early summer use. The plant is very hardy and the very early crop may be planted in a hotbed and transplanted to the open field like cabbage. Ordinarily it is sown in the open field in May or early June, where it is to stand. The rows should be 2½ feet apart and the plants stand about 2 feet distant in the row. A few seed should be put in each hill and but 1 allowed to grow after danger from flea beetles is past. Early varieties, like White and Purple Vienna, mature in 2½ to 3 months after planting seed. They should be eaten before fully mature.

For enemies see *Cabbage.*

LEEK (*Allium porrum*)

A hardy, flat-leaved, bulbous perennial of the onion family. (Fig. 164.) Its flavor is somewhat milder than the onion. The blanched stems and bulb are used for seasoning in cookery in the same manner as the onion. It is not much cultivated in this country except near large cities and where there is a considerable foreign population. The seed should be started in a hotbed or window box early in spring. When the plants are 5 or 6 inches tall in May or June they should be transplanted. At this time the tops should be cut back half and the plants set deep in drills 12 to 15 inches apart and 6 to 9 inches asunder. In cultivating dirt should be gradually drawn up around the plants to blanch them. Plants transplanted in May will mature by late August.

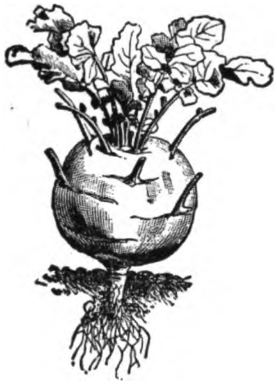


Fig. 163—KOHLRABI

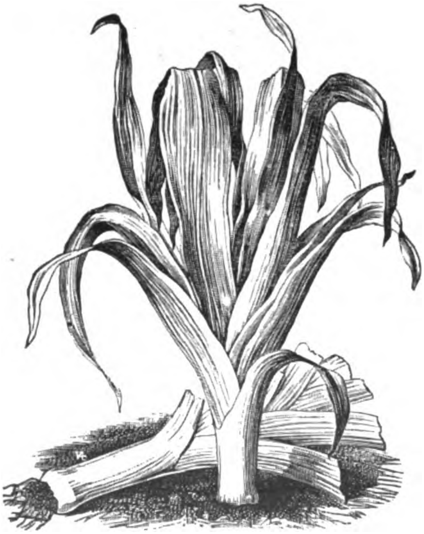


Fig. 164—CARENTAN LEEK

LETTUCE (*Lactuca sativa*)

This is a salad plant of first rank. It is extensively forced in greenhouses during the winter and in hotbeds and cold frames in early spring. Out of doors it is planted from spring until fall. It will withstand quite a severe frost without injury. In farm practice the seed may be sprouted in boxes, kept in the kitchen window, or in a small hotbed or cold frame like cabbage, and then transplanted to the garden as soon as the ground can be worked. It grows best in clay loam soil made rich with well-rotted barnyard manure. The plants should be set 12 inches apart each way. Frequently it is grown between the rows of other plants, like cabbage or cauliflower, and matures and is removed long before these need the space.

Ordinarily in farm practice the seed is sown in the open ground at intervals from early spring to October in rows about 1 foot apart and thinned to stand 6 or 8 inches apart in the row. The loose growing varieties mature the quickest and should be used for the very early and very late crops. The larger head lettuces are the finest for the early summer and fall crops. The crops should be grown rapidly if crisp, tender lettuce is to be secured. To this end the soil should be very rich. A quick growth is sometimes secured by the application of nitrate of soda scattered broadcast along the rows at the rate of 200 to 300 pounds per acre and well raked in. White Tennis Ball or Boston Market is a very good variety for early spring use. Hanson (Fig. 165) is a solid headed form suitable for spring or early summer. Salamander is another good summer sort, and there are many others. In growing lettuce much depends on the manner in which the seed is grown. The

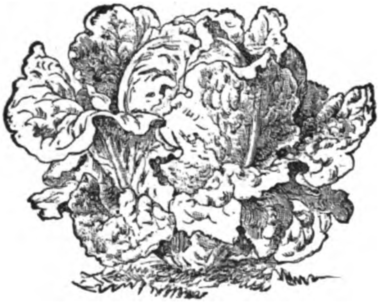


Fig. 165—HANSON LETTUCE

difference between properly grown and carelessly grown seed is shown in Fig. 166.

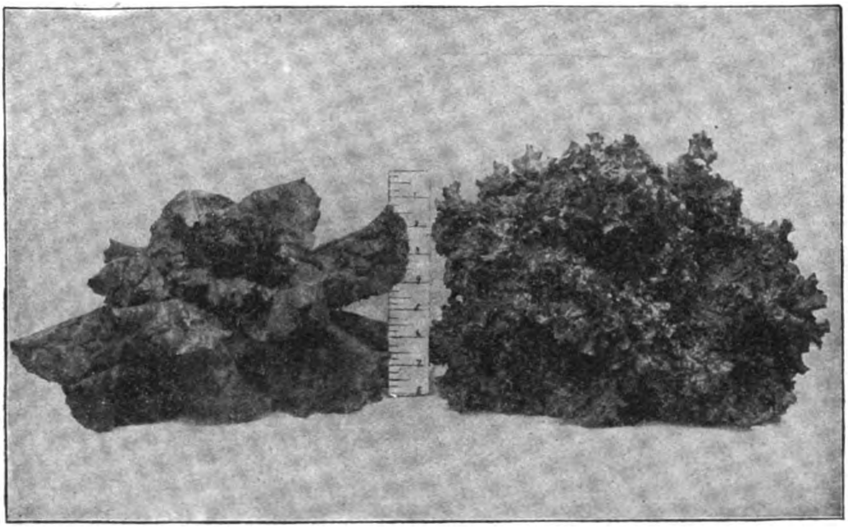
Of late years lettuce has become one of the most important vegetables grown in the greenhouse. It is started in flats in the fall and ultimately transplanted either to benches or pots in the greenhouse. If grown in pots 2 or 3-inch sizes are used. The pots are plunged in a bench so that the tops are covered about half an inch with soil. In pot culture, compact early maturing heads are secured, which may be marketed without disturbing the roots. The plants thus keep fresh for a long time when exposed for sale. In winter culture the sun is low and the days are short and often cloudy, and the time required to mature a crop is thus often prolonged 2 to 4 weeks. Experiments at the New York Cornell and other stations indicate that the crop may be hastened 10 days to 2 weeks by the use of ordinary electric arc lights or incandescent gaslights. By the use of the latter at the West Virginia Station the lettuce grown was taller, heavier, grew faster and matured quicker than lettuce grown under normal conditions. Ordinarily a crop of lettuce matures in the greenhouse within 6 or 7 weeks from the last transplanting. The varieties most grown in greenhouse or hotbed forcing are New Hothouse, Grand Rapids and Boston Market. A crop of lettuce grown under glass is seen in Fig. 167.

Enemies: DROP—See *Stem Rot* under *Cucumber.*

LEAF ROT appears first in the lower leaves which lie on the ground. The green blade rapidly rots away, leaving the midrib unaffected. In plants attacked by drop or leaf mold the midrib is affected first.

DOWNY MILDEW (*Bremia lactucae*) appears as large yellow or dead spots on the upper side of the leaves, with corresponding mildewed areas on the lower side. The disease spreads most rapidly under moist conditions.

ANTHRACNOSE (*Marsonia perforans*) attacks the leaves in small areas, which die and fall out, leaving holes in the leaf blade. Small leaves become much distorted and drawn together.



Plant from carelessly grown seed **Plant from properly grown seed**

Fig. 166—PRIZE HEAD LETTUCE
(U. S. Dept. Agr. Yearbook, 1899)

Lettuce is also subject to the attacks of bacterial stem rot, leaf mold, leaf spot and nematodes.

Drop and leaf rot may be entirely checked by sterilizing the soil or by covering the soil to a depth of 2 to 4 inches with sterilized sand. All lettuce diseases are most prevalent in, or almost confined to, greenhouses. Badly infected soil may be removed and the house refilled or the soil may be treated with hot water. Subirrigation lessens the amount of rot by reducing the surface moisture. Fumigation by hydrocyanic acid gas has a slightly beneficial effect in controlling lettuce diseases. It should be remembered that lettuce grows vigorously at rather low temperature, while rot thrives best at higher temperature.

CABBAGE PLUSIA—See under *Cabbage.*

FOUR-LINED PLANT BUG—See under *Currant.*

CUTWORMS—See under *Onion.*

MARTYNIA (*Martynia proboscidea*)

A large leaved, nearly prostrate plant (Fig. 168), native from Indiana southward, and grown to some extent in gardens for its half-matured seed pods, which are used as pickles. The plant is an annual and requires a rich, warm soil. Plant in hills 3 to 4 feet apart each way after frost is gone for the year. One plant to the hill is sufficient. The seed pods mature for pickling in 60 to 80 days and are preserved in the same way as cucumbers. Seed may be started in frames and transplanted or sown in place in the open.

MINT

The peppermint cultivated commercially in Michigan, New York, Northern Indiana and a few other localities for the production of oil is *Mentha piperita.* (Fig. 169.) The common spearmint cultivated everywhere in gardens for use in preparing meat sauces, salads, soups, stews, and for mixing with liquors, is *Mentha viridis.*

Peppermint is most profitably cultivated on muck soils or reclaimed swamp lands. It is propagated by means of running rootstocks known as "roots." These are from 1/8 to 1/4 inch in diameter and 1 to 3 feet long. The ground should be fall plowed and cultivated. In the spring it should be cultivated again and rows marked off 2½ to 3 feet apart. The "roots" are laid in these rows practically end to end so that there is a continuous line of roots, and kicked in with the feet. The roots are planted about the time corn is put in. An acre of plants will furnish enough roots to plant 8 or 10 acres, and a man will set about an acre a day. On large farms the roots are put in by a mint planter. The new plants appear in about 2 weeks after setting. Mint requires constant cultivation to keep down weeds. The crop is cut with a mower or by hand with a scythe when first in bloom, allowed to cure like hay, then raked into rows or heaps and drawn to the still. Where the season is long 2 cuttings can be secured the same year. The ground is plowed to a depth of 6 inches each fall and the crop comes on again without resetting. The second and third year crops are considered most profitable.

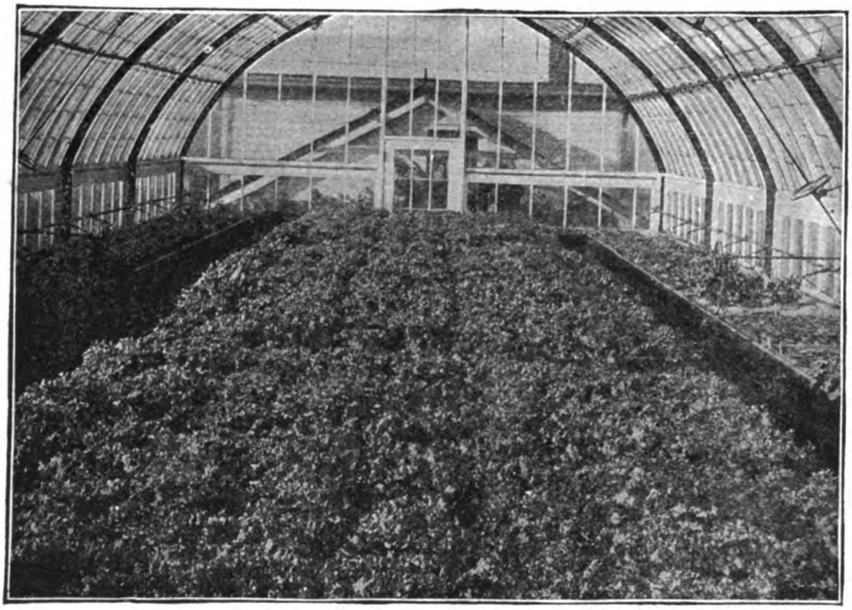


Fig. 167—LETTUCE FORCING HOUSE
(U. S. Dept. Agr.)

The oil is extracted by distillation. The plants are placed in a large vat with a perforated false bottom and steam run through it for 35 minutes to an hour. The oil, being volatile, is carried out with the steam into a long worm condenser cooled with water. It is collected in vats and the oil readily rises to the top and is drawn off. The yield of oil varies from 10 to 60 pounds per acre and averages 20 to 25 pounds. The cost for distilling is about 25 cents per pound. The crude oil sells all the way from 75 cents to $4.50 per pound and averages from $1.25 to $1.50 per pound. The hay remaining after the oil is distilled is of considerable value as a stock food.

Fig. 168—MARTYNIA

The mint now commonly grown in the United States is Black Mint or Black Mitcham. American Mint or "State Mint" of New York has long been grown here, but is not so productive as the Black Mint. White Mint is less productive than either and too tender for general cultivation. The Japanese Mint (*M. arvense piperascens*) is not cultivated commercially here. It contains a larger percentage of menthol than the other sorts, but the oil is considered inferior in quality to Black Mint.

Spearmint is also cultivated and distilled like peppermint, but there is less demand for it. It is easily grown in gardens from rootstocks and persists from year to year with little care.

MOLES

Moles are small, familiar animals, readily distinguished by their soft dark fur, long pointed nose and large, strongly developed front feet, which are used in throwing aside the dirt in making their burrows. The relationship of moles to agriculture has often been misunderstood, and it is probable that much, if not all, of the injury which is attributed to moles in gnawing the roots of fruit trees and garden crops is really due to mice. Moles and their nearest relatives, the shrews, are almost exclusively insectivorous in feeding habits and burrow through the ground in pursuit of insects. They are usually to be considered beneficial on account of these habits, but when they burrow extensively in lawns or about the roots of some garden plants they may cause considerable damage. If it is desirable to exterminate them they may be captured in their burrows in the evening by a shovel and spade, or by the use of traps, and carbon bisulphid applied in a manner similar to that recommended for ground squirrels is also very effective. (Pa. Dept. Agr. Bul. 31.)

MUSHROOMS

These are frequently called toadstools. Many edible and poisonous species are common in woods and meadows, but the one usually gathered and eaten or sold in the market is *Agaricus campestris.* This is common in old meadows in the fall and is characterized by having pink colored gills. It varies in hight from 1 to 3 inches and in diameter from 2 to 4 inches. Many misleading statements have been made regarding the food value of mushrooms, the term "vegetable beefsteak," etc., being applied to them. Many analyses and digestion experiments show that 75 to 92 per cent of mushroom is water, and the total

Fig. 169—PEPPERMINT

amount of protein present is comparatively small. Not more than half the dry matter present is digestible. Mushrooms are inferior in food value to potatoes, and this statement about summarizes their feeding value except from the standpoint of a relish and variety.

Mushrooms are extensively cultivated in the vicinity of cities and bring good prices. The mushroom plant itself is a white or bluish-white mold that grows just beneath the surface of the soil. The part above ground that is seen and eaten may be called the fruit of the plant. (Fig. 170.) This mold or fungus forms a network of threads underground. When grown in specially prepared soil and dried in cakes or flakes it becomes known as spawn and is used for starting new mushroom beds. The details of mushroom growing and the characteristics of the many native edible and poisonous species are too extensive for treatment here. Growing mushrooms from spawn is treated in U. S. Dept. Agr. Farmers' Bul. 53. Other bulletins on mushrooms are Ark. Expt. Sta. Bul. 27, Ala. Expt. Sta. Bul. 73, N. Y. Cornell Expt. Sta. Buls. 138 and 168. There are also many books on the subject. Consult that by G. F. Atkinson, entitled "Mushrooms, Edible and Poisonous," and "Mushrooms, How to Grow Them," by William Falconer.

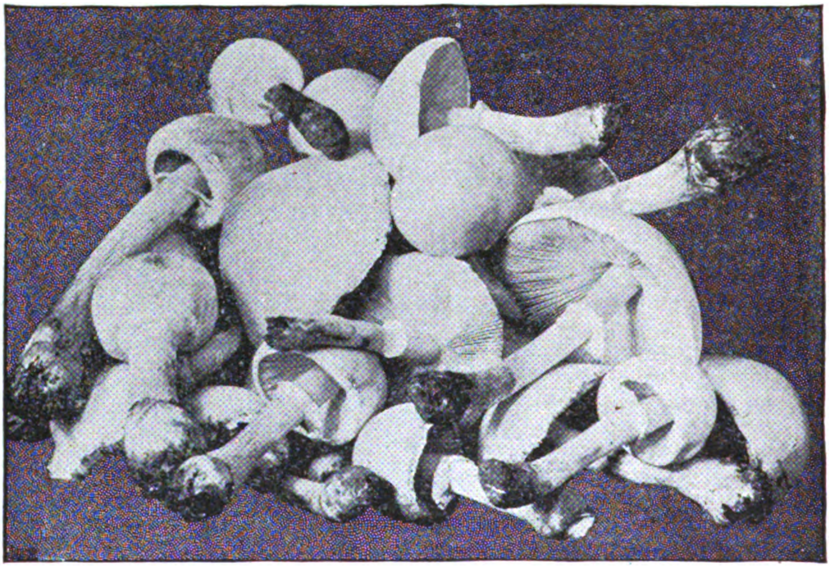


Fig. 170—EDIBLE MUSHROOMS
(N. Y. Cornell Expt. Sta.)

MUSKMELON (*Cucumis melo reticulatus*)

An annual trailing vine, sensitive to frost, bearing round or oval fruits which weigh from 1½ to 6 pounds. It is successfully grown all over the United States and is an important commercial product. It resembles the cucumber in manner of growth and is cultivated like it. Contrary to the usual belief, it does not cross with cucumbers, squashes, etc., and the quality of the fruit is not injured when they are planted with or near these crops. The term cantaloup is frequently but incorrectly applied to the whole group of muskmelons. It is properly applied to only 1 group (*C. melo cantalupensis*), which is characterized by a hard, scaly and often deeply furrowed rind, having a warty appearance like a Hubbard squash. The cantaloup is little grown in this country, but is prized in Europe.

Soil and Planting—The muskmelon requires a quick, warm, sandy loam for its best growth. It is a long season crop, and in the North, especially, the plants are frequently started under glass. Experiments at a number of stations show but little, if any, advantage for this practice over outdoor planting. In Arkansas, however, it increased the earliness of the crop from 12 to 20 days. In farm practice transplanting is not advisable, but the special grower may find it profitable. Muskmelons transplant with difficulty. It is generally advised that they be planted on thick sods cut 4 inches square. These should be placed close together, grassy side down, in a hotbed, hollowed out some, a little rich dirt filled in, and 6 to 8 seeds planted on each. Bottomless berry boxes or tin cans filled with rich soil may be used in the same way. The plants should be hardened off and set in the field after all danger of frost is past, and the 3 strongest plants allowed to stand in each hill. A cloudy day or late in the afternoon is the best time for transplanting. In dry weather a pint or more of water should be given each hill after the plants are set.

Fertilizing—The usual practice in growing melons outdoors is to plant 10 to 15 seed in hills 3 feet apart in rows 6 feet apart. In growing on a small scale a couple shovelfuls of well-rotted barnyard manure should be put spade deep under each hill. Three or 4 inches of soil should be put over the manure, the seed planted and covered with 2 to 3 inches more of soil, making the top of the hill slightly above the level of the ground. After danger from insects is past the plants should be thinned to the 3 strongest plants in the hill.

At the Arkansas Station Walker found that applying the manure to the surface of the ground and working it into the soil with a fork gave just as good or better results as regards yield, size and earliness of melons as by digging a hole and putting it under the hill or in trenches around the hill, and was much cheaper. In commercial practice he recommends that the manure be applied in strips 8 to 10 feet apart on well-prepared land. The manure should be mixed with the soil by passing back and forth several times along the strip with a bull tongue or single shovel plow, after which the soil should be thrown into a low, broad ridge, dragged and harrowed. On this strip the seed should be planted about 18 inches apart.

The New Jersey Station secured an increase in yield of muskmelons of 115 per cent by the use of 150 to 200 pounds of nitrate of soda per acre. Half the fertilizer was applied at planting time about the hills and worked into the soil, and the remainder about 3 weeks later. Dried blood and sulphate of ammonia used in the same manner were a little less effective, but increased the yield from 87 to 91 per cent. A handful or two of fertilizer should be mixed into the soil of each hill.

In the West where irrigation is practiced the water should be kept confined to the furrow and reach the roots of the plants only by percolation. This keeps the melons dry and the vines from becoming covered with sand.

Varieties—Muskmelons vary much in size, shape, color of the flesh and quality. There are many varieties. Only a few of the more popular sorts are referred to here. Rocky Ford in Colorado has become famous for its muskmelons, the variety grown being an improved form of the Netted Gem known as the Rocky Ford. (Fig. 171.) This is a small green-fleshed, netted melon, weighing about $1\frac{1}{2}$ pounds, and of excellent quality. It is one of the best shippers and is extensively grown in the East. Other varieties planted by large growers are Jenny Lind, a small green-fleshed variety; Hackensack, a somewhat larger variety; Osage, a yellow-fleshed melon weighing 3 to 6 pounds, and Montreal Market, a very large variety with fruit weighing 6 pounds or more. This is a very popular variety in the Boston market and an excellent shipper. All of these are excellent for home use. In Fig. 172 are seen 6 varieties which have been found best for Southern markets: (1) Augusta, (2) Anne Arundel, (3) New South, (4) Delmonico, (5) Chicago Market, (6) Long Island Beauty.

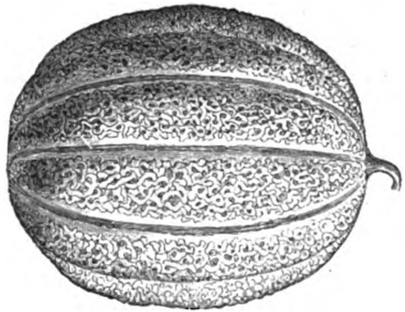


Fig. 171—ROCKY FORD MUSKMELON

There is a class of muskmelons known as winter muskmelons (*C. melo* var. *inodorous*), which if picked before frost and stored in a cool place ripen up slowly, often keeping until Christmas time. These melons are poor in quality, but compensate in part by their long-keeping qualities. Among the best of these are Winter Climbing, Nutmeg, White Antibes and Winter Pineapple.

Enemies: LEAF SPOT (*Phyllosticta cucurbitacearum*) is mostly confined to the foliage, but attacks also the young growth. Light colored spots appear and the affected tissue falls out, leaving irregular holes in the leaves. The trouble may be controlled by spraying with standard fungicides.

DOWNY MILDEW—See under *Cucumber.*

WILT—See under *Cotton.*

BACTERIAL DISEASE usually affects only 1 plant in a hill, but sometimes all are affected at once. The leaves suddenly wilt down and wither, while the stem dries up or rots. When 1 branch only is affected it may be removed in time to save the rest of the plant. The bacillus which is the cause of the disease may be carried from plant to plant by insects. It clogs up the vessels and shuts off the water supply. Fungicides will not check this disease. Affected plants should be dug up and destroyed.

LEAF BLIGHT causes large dead areas in the leaves. The spots are larger than in the case of downy mildew, and the central part has a tendency to fall out. Careful and repeated spraying with Bordeaux mixture at 14-day intervals before August 1 and at 10-day intervals after that date will check the disease.

ANTHRACNOSE (*Colletotrichum lagenarium*) attacks young fruits, spreading from the blossom end. The diseased part turns brown or black and shrivels up. The trouble may be controlled by repeated spraying with Bordeaux mixture.

For insect enemies see under *Cucumber* and *Squash.*

MUSTARD (*Brassica* spp.)

Mustard is grown for "greens" and for seed, the latter forming the well-known condiment. The best of the mustards for greens is *B. Cyaponica* (Fig. 173) and *B. alba.* The Black Mustard (*B. nigra*) is the one chiefly grown for seed. Mustard requires a warm, rich soil, preferably of a sandy loam nature. It is seeded either broadcast or in drills; if broadcast about 8 quarts of seed per acre are required; if in drills 24 inches apart 6 quarts is sufficient. Plants are left 6 to 12 inches apart in the row. When a majority of the pods have turned yellow the crop is cut with a reaper or scythe and put in piles for a day or so to cure. It is then drawn to the barn, and, when perfectly dry, threshed.

Mustard frequently becomes a weed, but is easily controlled by cultivation.

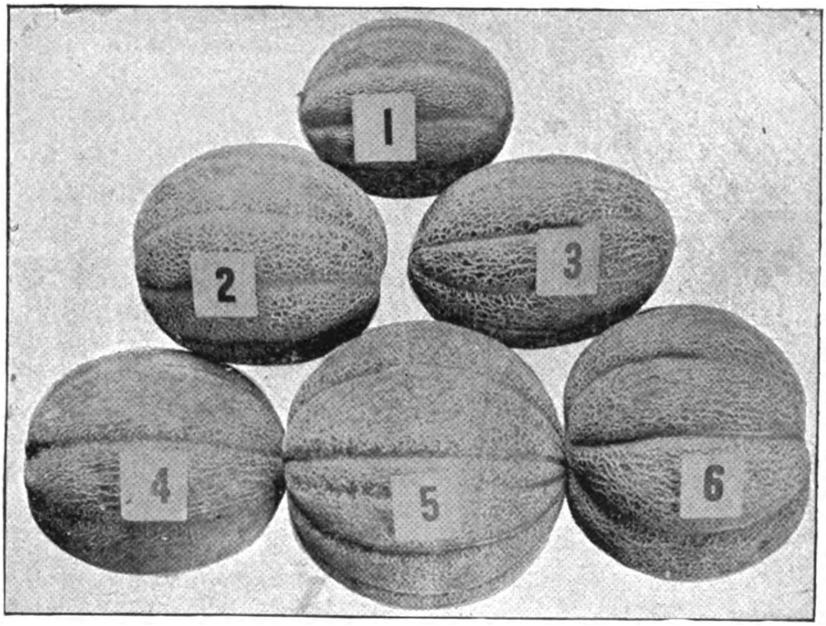


Fig. 172—LEADING VARIETIES OF SOUTHERN MUSKMELON

OKRA or GUMBO (*Hibiscus esculentus*)

A tender annual vegetable of easy culture. It is grown mostly in the South. The part eaten is the green mucilaginous pods, which are used in soups, sauces and stews. It thrives in all garden soils. The seed is sown about the time snap beans are put in. It should be seeded 1 inch deep in drills 2 to 3 feet apart, depending on the size of the variety grown, and the plants thinned to stand 12 to 18 inches apart in the row. The green pods are used for cooking as long as they snap readily. Older pods should be removed so that the plant will remain longer in bearing. The green pods may also be preserved in brine like cucumbers or dried for winter use.

Fig. 173—JAPANESE MUSTARD

Dwarf varieties are best for the Northern States. Of these, Dwarf Green (Fig. 174), Little Gem and Velvet are among the best.

For enemies see under *Cotton*.

ONION (*Allium cepa*)

This vegetable is chiefly grown from seed. The crop is also grown from onion "sets," which are very small onions; from "tops," which are small bulbs produced on the tops of onions in place of flowers, and from multipliers or potato onions, which are bulblets formed by division of the parent bulb. The "sets," "tops" and multipliers are of especial value in growing early onions, while the main late crop is grown from seed.

Soils and Fertilizers—The best soil for onions is a rich, well-drained loam. Heavy clays, hillsides and stony land should be avoided. Excellent crops are grown on deep, rich muck lands that have been under cultivation for 3 or 4 years. Such lands should contain a fair admixture of sand and the water level be about 2½ feet below the soil surface. New, raw muck lands give poor returns. The land for onions should have been into some heavily manured hoed crop the preceding season and practically free from weed seed. It is a mistake to attempt to grow onions on weedy or run-down land.

A rather firm seedbed which results from fall plowing is desirable and gives the best results. A second crop of clover heavily fertilized with barnyard manure and turned under in the fall, followed by potatoes the next spring, makes an excellent preparation for onions the second year. A heavy top dressing of well-rotted barnyard manure or compost should be applied in the spring at the rate of 40 to 50 2-horse wagon loads and well worked into the soil with a disk harrow or narrow bladed cultivator; after this a complete commercial fertilizer analyzing 4 per cent nitrogen, 8 per cent available phosphoric acid and 10 per cent potash should be applied. This is the fertilizer formula so popular with Long Island onion growers and should be applied broadcast at the rate of 500 to 1500 pounds per acre. If the land has been in a high state of cultivation for some years the commercial fertilizer may replace in part the barnyard manure. Onion soil, however, cannot be made too rich. A top dressing of ashes and hen manure might also replace in part the commercial fertilizer. The most successful growers use them all, and, in addition, from 250 to 750 pounds of nitrate of soda applied broadcast in 3 or 4 applications during the growing season. It must be remem-

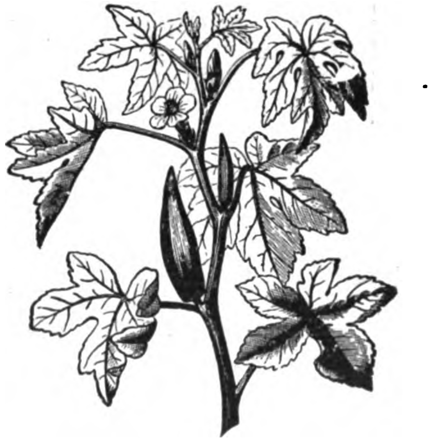


Fig. 174—DWARF GREEN OKRA

bered that it costs just as much to seed and cultivate a crop of onions that yields 300 bushels per acre as it does to grow a crop yielding 800 to 1000 bushels per acre. And further, that the land once prepared can be used for growing onions year after year unless insects or diseases come in.

Seeding—After the top dressing of fertilizers, hen manure, ashes, etc., has been applied it should be lightly harrowed in and the ground leveled with a smoothing harrow preparatory to seeding. The onion is one of the hardiest of our vegetables, and the seed should be in the ground as early in the spring as the land can be worked. In the North the seeding should be completed by the middle of May. Farther south seed is sown from February to April, and in Texas and some other localities fall seeding is practiced. The rows should be 12 to 14 inches apart in hand cultivation and about 30 inches in horse cultivation. Hand cultivation is usually practiced, and at the Texas Station was found to be as cheap and much more profitable than horse cultivation.

From 18 to 30 seed, depending on their vitality and the danger from grubs, are sown per foot of drill and covered 1 inch deep. Care should be taken that the seed drill drops correctly. Buy only the best seed. From 3 to 6 pounds are required per acre. The Texas Station states that Bermuda onions from American grown seed do not mature or keep as well as when grown from foreign seed. With the Creole variety American grown seed is the best. With good seed about 90 per cent ought to germinate. The rows should be straight to facilitate cultivation.

Cultivation—Cultivation should begin as soon as the young plants appear, using a wheel hoe, which loosens the soil on both sides of the row and throws it slightly away from the plants, as seen in Fig. 175. Hand weeding should follow promptly, and thinning, if necessary. The plants should stand about 3 inches apart in the row, but if the soil is rich they will stand crowding, and if it is not sufficiently fertile it will pay to add enough more fertilizers to mature the crop rather than go to the expense of thinning unless the plants are altogether too close, which is not likely to happen from medium seeding. Throughout the growing period the crop should be hoed whenever weeds appear or the ground becomes hard and packed, practicing always shallow cultivation and keeping the ground level. The field will need to be gone over every 10 days or 2 weeks. When bulbs begin to form cultivation may be lessened.

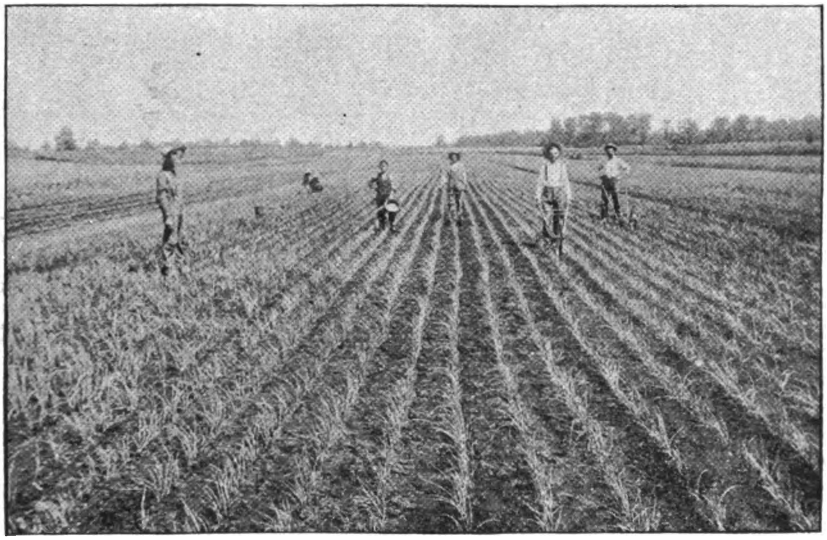


Fig. 175—ONION WHEEL HOE IN OPERATION

Harvesting—As the onion bulbs approach maturity the stalks become weak just above the bulbs and fall over on the ground. When the bulk of the tops have died down the crop is ready for pulling.

even if some tops are still green and standing. Throw 2 or more rows together and leave on the ground for a week or more to cure. The tops of the onions may be twisted or cut off at any time before marketing, but preferably when they are stored.

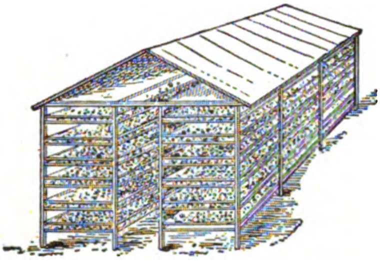


Fig. 176—ONION CURING SHED

Storing Onions—If the onion crop is kept over till spring it should be stored in a dry, cool place. In a damp cellar they are almost certain to sprout, even if the temperature is nearly down to freezing. A dry loft is the best place for them. Freezing does not harm them, but repeated freezing and thawing makes them soft and induces sprouting. If they are frozen at the beginning of winter they should be kept so until spring. After they thaw out they do not keep well and should be disposed of as soon as possible. Onions should never be put in deep piles, but spread out in shallow layers not more than 12 to 18 inches deep. They keep well in barrels with the heads out and holes bored in the sides to admit of a good circulation of air, or in slatted bins. A serviceable onion curing shed is shown in Fig. 176.

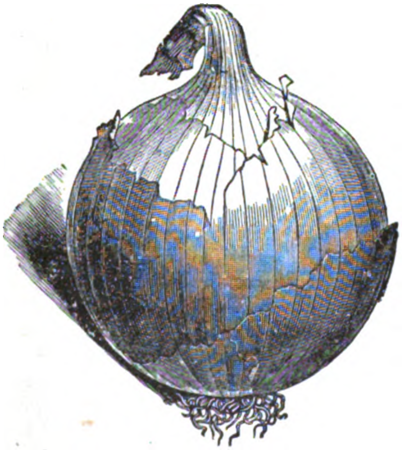


Fig. 177—YELLOW PRIZETAKER

"The New Onion Culture"—The bulk of black seed onions are grown in the field, as noted above, but within the past 12 years a new method of onion culture has come into prominence. It has been tested by a number of the experiment stations and proved a decided success. It consists in sowing the seed in the greenhouse or in hotbeds about 6 weeks in advance of the time when the ground is usually fit to work out of doors and then transplanting to the field. The advantages of this method are a greatly increased yield, more onions of a marketable size, minimum cost for seed and the possibility of growing the larger and more delicately flavored foreign onions. The extra labor in planting it is claimed is fully offset by the saving in labor of weeding and thinning.

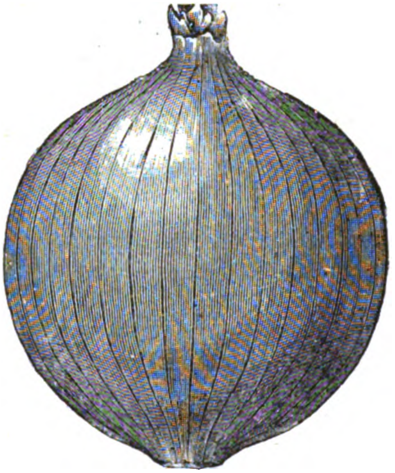


Fig. 178—SOUTHPORT LARGE YELLOW GLOBE

In growing onions by this method the seed is sown in January or February in the greenhouse or hotbed, or on a small scale in boxes kept in the kitchen window, using only moderately fertile soil. The drills are made about 2 inches apart and the seed sown rather thickly, using 12 to 15 seeds to each inch of drill. The young onions are easy to transplant. Children can do it successfully if superintended, and reduce the cost. The soil should be prepared exactly as noted above under the field culture of onions from seed. Onions grow best in cool weather, and so should be set out in the open field as soon as the ground can be prepared. Shear off about half the tops and a small portion of the roots, and set about an inch deep 2 to 3 inches apart in rows 12 inches apart. Just before the plants are set out the ground should be raked to destroy all weeds. The cost of transplanting is about $35 per acre. It requires about 160,000 plants per acre, and a good man will put in about 4000 plants per day. The subsequent cultivation and handling of the crop is the same as noted for field onions grown from seed.

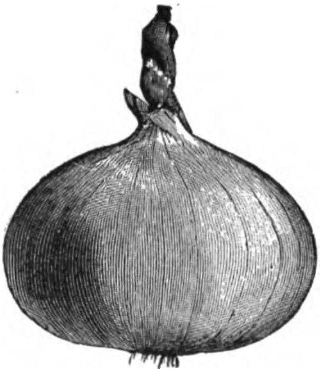


Fig. 179—YELLOW GLOBE DANVERS ONION

Early Onions—The early green onions of spring are usually grown from sets or bulblets. Onion sets are grown by drilling in 30 to 40 pounds of seed per acre. Soil of only medium fertility is used and the seeding delayed in the spring until after most of the weeds have started. The object of thick seeding is to secure a crop of very small bulbs from the size of a pea to half an inch in diameter. They should be harvested in August or September and treated like the main crop of field onions. When these small onions (sets) are planted out 2 to 3 inches apart in rows a foot apart and about 3 inches deep they form a new bulb, which is ready for bunching and the table by early summer. Good, well-enriched soil should be used and the plants kept cultivated, throwing the soil toward the plants. In the South sets and multipliers or potato onions may be put out in the fall. The use of sets practically insures a crop. It requires from 6 to 10 bushels to set out an acre.

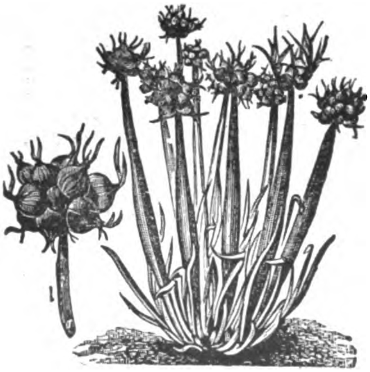


Fig. 180—EGYPTIAN TREE ONION

Varieties—The most popular varieties of market onions are the yellow or white globular sorts. Medium sized rather than very large onions are most in demand, except of the foreign sorts; then the larger in size the better. The foreign onions are grown mostly by the transplanting method. Prizetaker (Fig. 177), a light yellow, mild flavored sort, is one of the best of these and oftenest planted. For outdoor seeding Southport Large Yellow Globe (Fig. 178) and Yellow Globe Danvers (Fig. 179) are excellent varieties. These and Extra Early Red are especially valuable on muck lands. Red Wethersfield is considered one of the most certain for growing in the North. The Extra Early Red is one of the earliest of the large onions. New Queen is a small white pickling onion. Potato onions and Egyptian or Perennial Tree onions (Fig. 180) are grown only from bulblets and are of especial value in early marketing in the green state. The comparative size of round onions is shown in Fig. 181.

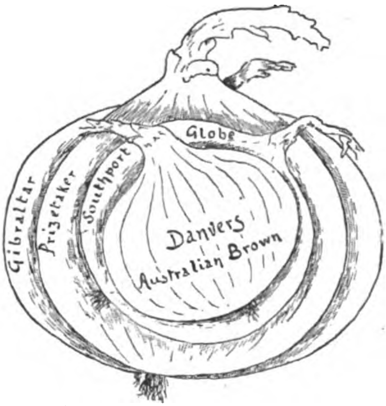


Fig. 181—COMPARATIVE SIZE OF ROUND ONIONS

Enemies: SMUT (*Urocystis cepulae*) occurs on young plants, appearing as dark spots or lines on the leaves. Later a black powder is exposed by rupture of the diseased spot. In severe cases the tops die and the disease spreads to the bulb. (Fig. 182.) All rubbish should be burned after harvesting and rotation of crops should be practiced.

Smut may be largely avoided by transplanting. Mixtures of equal parts of sulphur and lime or sulphide of potassium and lime, applied in the drills at the time of seeding, are very effective.

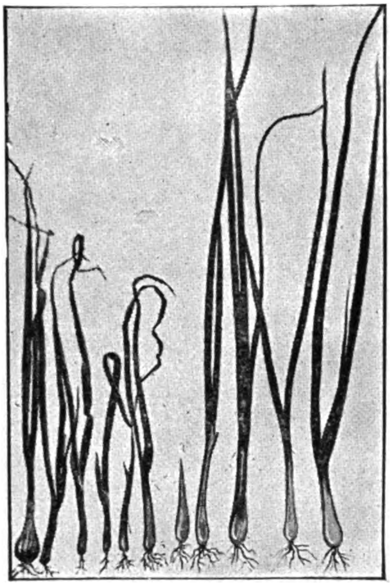


Fig. 182—ONION SMUT
Diseased plants on left
(Ohio Expt. Sta.)

Onion seed may be sprayed before covering with formalin in the proportion of 1 ounce to 2 gallons of water.

Downy Mildew (*Peronospora Schleideniana*) is especially injurious to seedlings on low grounds, and appears as a gray felted coating on the onion tops. The plants wilt and turn yellow at about the time the bulbs are forming. The disease winters over in affected onions. Diseased onions should be destroyed and the plants should be sprayed early in the season with Bordeaux mixture.

Anthracnose (*Vermicularia circinans*) attacks the outer bulb scales of white onions just before harvesting. The bulb is covered with a black fungous growth. The fungus later penetrates through several layers and causes a decay of affected parts. The disease becomes most conspicuous on onions after they are harvested. They may be much disfigured. Onions should be quite dry before being stored and should be kept in a dry, cool place. Slight dusting with dry air-slaked lime may prevent the spread of the fungus after harvesting.

Mold appears most conspicuously on seed stalks as a black velvety coat. Mold frequently occurs in connection with downy mildew. Parts attacked by mold absorb moisture readily and rot. No direct remedies have been devised. All old stalks and field refuse should be burned.

Bacterial Rot appears as a decay of the exterior or interior layers of the bulb. (Fig. 183.) The disease is only injurious in the presence of an undue amount of water. Clean cultivation and thorough drainage are suggested as preventive measures.

The most serious insect pest of onions is the Root Maggot (Fig. 184), which closely resembles the cabbage maggot, and may be treated in the same manner. (See under *Cabbage*.)

Onion Thrips (*Thrips tabaci*) is a pale yellow insect resembling the strawberry thrips, and attacks onion, cabbage, cauliflower, etc. It sucks the juice from the leaves and causes the latter to turn white, shrivel up and die. For remedies see *Thrips*, under *Strawberry*.

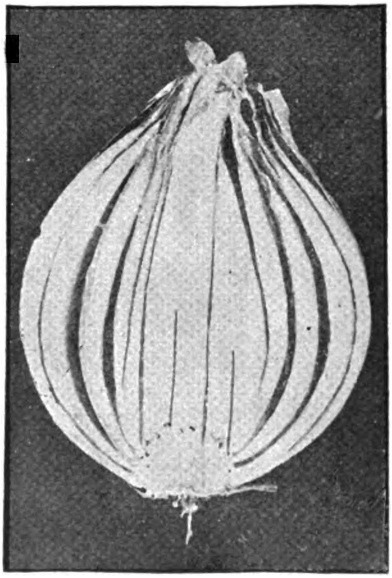


Fig. 183—BACTERIAL ONION ROT
(N. Y. State Expt. Sta.)

The army worm and cutworms often cause great damage to onions.

Cutworms is a term which is used to indicate a number of smooth caterpillars of similar habits. Cutworms are of a neutral green, gray or brown color. They feed at night and remain hidden by day under rubbish or in the soil. The adults are medium sized moths of a neutral color, which often fly to lights at night. Cutworms are especially injurious to corn, clover, alfalfa, onions and various garden crops and to fruit trees. Several species of cutworms have the habit of crawling up the trunks of trees and eating out the buds in spring; these species are commonly known as climbing cutworms. (Fig. 185.) When food becomes scarce cutworms may adopt the habit of army worms and may migrate, devouring every green thing in their course of travel.

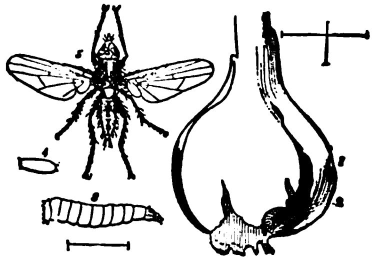


Fig. 184—ONION MAGGOT
1, the affected bulb; 2, the maggot at work; 3, the larva; 4, the pupa; 5, the fully developed insect

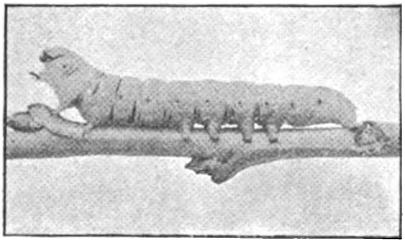


Fig. 185—CLIMBING CUTWORM

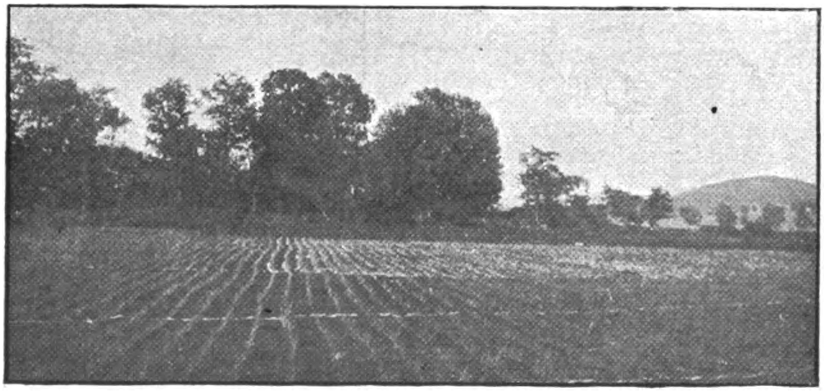


Fig. 186—PLAN OF DISTRIBUTING POISONED BAIT FOR CUTWORMS
(N. Y. State Expt. Sta.)

The operation of lantern traps and sweet traps, to which the moths are supposed to be attracted, is too expensive and the results are too unsatisfactory to permit these methods to be generally recommended. Clean cultivation in orchards should be followed; all weeds and other vegetation should be kept out, especially after July 15, since the eggs of cutworms are usually laid on such plants. Climbing cutworms may be prevented from injuring orchards by painting a band of Raupenleim or Dendrolene around the trunks of trees. Stiff collars shaped like an inverted funnel applied to the trunks of trees will also give good results. Cabbage and other garden plants may be protected by setting a cone of tin or tarred paper around each plant. Poisoned baits have proved very effective in combating cutworms. For this purpose clover, or other green herbage, may be sprayed with Paris green. Such poisoned baits should be placed where the cutworms will readily find them and must be renewed every 2 or 3 days. Cutworms are very fond of bran or middlings and effective poisoned baits may be made by mixing these substances with Paris green. This bait may be scattered between the rows of onions or other garden vegetables or distributed by means of an onion seed drill, and thus deposited evenly and continuously about the margins of the fields before the advancing destroyers, as seen in Fig. 186. In localities where water can be had for irrigation, ditches containing running water will serve as effective barriers to cutworms when on the march. Other methods of combating cutworms are discussed in connection with the army worm under *Wheat.*

PARSLEY (*Carum petroselinum*)

The leaves of this plant are used for garnishing meat, fish and other dishes and as a flavoring for soups and stews. The plant is a low growing perennial, usually cut-leaved. (Fig. 187.) It grows in any good garden soil. The seed are very slow to germinate. They should be sown early in the season in rows 10 to 12 inches apart and the plants thinned to stand 3 to 4 inches in the row. A few plants will supply a family. If protected the plants will live over winter, or the roots may be put in boxes or pots and kept in the house, where they will furnish a winter supply of leaves.

Fig. 187—MOSS CURLED PARSLEY

For enemies see under *Celery.*

PARSNIPS (*Pastinaca sativa*)

This is a hardy vegetable used for both human food and for stock. It is grown like carrots are. The soil should be deep, mellow and rich and of a loamy nature. The seed must be fresh—not over a year old. Sow ½ to 1 inch deep in rows 15 to 18 inches apart. The seed are slow to germinate and it is sometimes necessary to break the crust that may form in the soil over them before the plants will push through. Thin the plants to stand 3 to 4 inches apart in the row. Cultivate and keep the weeds out until the tops shade the ground. The crop may stay in the ground over winter and is improved in quality by freezing. If thus managed, however, the roots are frozen in during the winter and cannot be marketed if favorable opportunity offers. It is customary to dig them late in the fall and store in pits or in a cool cellar.

The Round or Early Short Round (Fig. 188) is one of the better smaller varieties. Half Long is well suited to medium deep soils, and Long Smooth to rich, deep soils. Stock readily eat the surplus or unmarketable crop.

For enemies see under *Celery.*

PEA

The common field and garden peas (*Pisum sativum*) only are considered here. For cowpeas, flatpea, chickpea, etc., see these articles.

Field Peas—The field pea is little grown in the United States, but is widely cultivated in Canada as a stock feed, and should be better known here. The crop has a high value for soiling and fodder and as a soil improver it stands next to clover. In the early stages of fattening and for growing stock no grain is more valuable or better than peas.

In this country field peas may be successfully grown for grain in the New England States and in northern portions of Michigan, Wisconsin, Minnesota and west to Washington and Oregon. In the southern portions of Michigan, Wisconsin and Minnesota and in Northern Ohio the grain crop is not so certain, though sometimes good yields are obtained. Farther south the temperature becomes too high for grain production, but throughout a very large section excellent pea forage can be grown. In the more southern States cowpeas take the place of nearly all other leguminous crops for forage and as a soil improver.

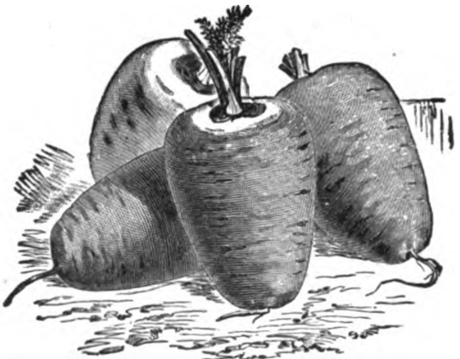


Fig. 188—EARLY SHORT ROUND PARSNIPS

Soil—Clay loams well supplied with lime give the heaviest growth and best yield of field peas. Even on the heaviest clays good crops can be grown. On light leachy sands the vines fail of full development for lack of moisture, while on muck lands too rank a vine growth occurs. On the light pine sands of Northern Michigan peas are one of the best crops grown for soil improvement.

Seedbeds and Seeding—As with other grain crops, the best results are secured with peas when the land is fall plowed, though peas will do better on spring plowed land, relatively, than any other grain crop. Peas are thankful for a well-prepared, well-tilled seedbed; but they are vigorous, hardy growers and will tolerate more neglect in this respect than many smaller seeded grains. The crop should be seeded as early in the spring as the ground can be worked. Drilling the seed in 2 to 4 inches deep gives better results than broadcasting. With the smaller varieties the seed should be put in at the rate of about 2½ bushels per acre. The larger varieties will require from 3 to 3½ bushels per acre.

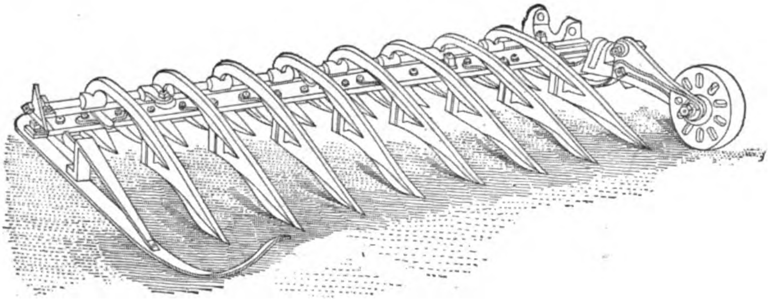


Fig. 189—PEA HARVESTER
(U. S. Dept. Agr.)

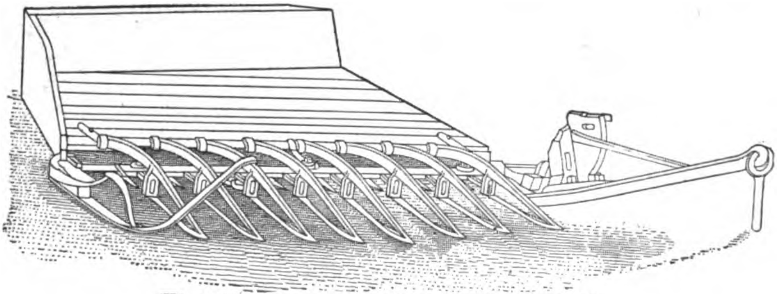


Fig. 190—PEA HARVESTER WITH PLATFORM
(U. S. Dept. Agr.)

The pea crop may occupy almost any place in a farm system of rotation; but usually some grain crop, like wheat or oats, should follow, since peas enrich the ground with nitrogen—a fertilizing element especially beneficial to these crops.

Harvesting—Field peas are harvested when the majority of the pods have matured and the vines are beginning to turn yellow. A pea harvester has been devised which greatly aids in the work of gathering the crop. It consists of a simple attachment to a mower (see Fig. 189), by means of which the vines are lifted and cut off, leaving them in a string-like swath behind the mower. Two men follow and bunch them out of the way of the horses. With some harvesters the cut peas fall on a platform (Fig. 190), and only 1 man is required to follow and throw them off. The former, however, is generally considered the more expedient way. Three men and a team should cut and bunch about 10 acres a day.

The bunches should be turned over at least once to facilitate drying, after which they may be stacked or put in under shelter. When stacked a good top of marsh hay or some like material should be put on to keep out the rain, as pea vines do not readily turn water. The same precaution must be observed when the threshed pea straw is stacked outdoors. Where large areas are grown it is desirable to thresh the grain with a thresher; where only small amounts are grown for seed for forage they are most economically threshed out with a flail.

Varieties—The term "Canada Field Peas" refers to any one of nearly 200 varieties grown in Canada. These varieties differ greatly from one another in methods of growth, size, yield, habit, etc. Extensive comparative tests have been made at 5 of the more important Canadian Experiment Stations and experimental farms with these varieties to determine their relative merits. Taking the average of all the results obtained in tests covering 3 to 6 years, the 8 varieties yielding heaviest are Crown, Carlton, Pride, New Potter, Early Britain, Duke, Mummy (Fig. 191) and Centennial. At the Ontario Agricultural College the variety White Wonder has given the best average results of a number of varieties tested for 8 years, averaging 37 bushels per acre. This variety is considered especially desirable for growth on comparatively rich soils because of its short growth of straw. It should not be planted on poor soils. The Prussian Blue is also considered one of the most hardy, prolific and reliable sorts grown in Ontario.

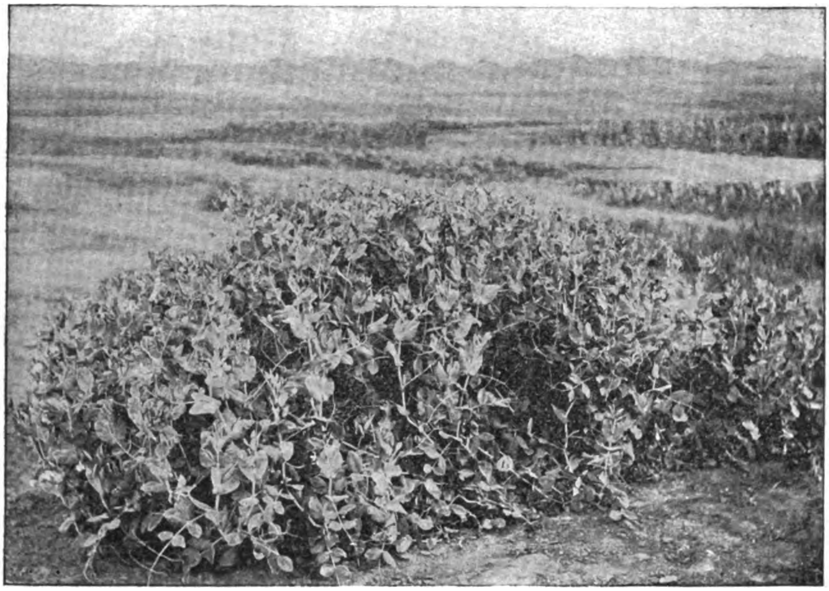


Fig. 191—MUMMY FIELD PEA

Feeding Value—For the composition of field peas see *Appendix*. Peas are rich in muscle, blood and bone making constituents and are therefore well adapted for all growing animals or animals at work. Experiments at the Utah and South Dakota Experiment Stations show that it requires less peas to produce a pound of pork than when corn is fed. In other words, peas, pound for pound, produce a greater gain with growing hogs than when corn is fed, and the pork produced is often firmer and of better quality. For fattening cattle peas are unexcelled. It is certain that in the early stages of fattening of all farm animals before full maturity of the animal is reached there is no better grain ration than peas. Peas mixed with ground oats, shorts or wheat bran in the proportion of 1-3 to ½ peas make an excellent ration for brood sows, ewes in milk, lambs, milch cows, horses at work and colts. For sheep, poultry and hogs peas do not need grinding, but for all other animals it is considered advantageous to grind. Pea meal is a rather heavy feeding stuff and should be lightened by mixing with bran, shorts, ground oats or other like material, as noted above.

Pea straw, when properly cured, is better and more relished by horses, cattle and sheep than the straw of any of the other small grains. Vines cut with a pea harvester while still a little green, and well cured and put up without being drenched with rain, approach clover in feeding value. Sown with oats or barley, peas make an excellent forage crop for cured hay or a pasture for hogs and sheep. For hay it should be cut just before the maturity of the predominating crop in the mixture. It is at its best for pasture just about the time all other grasses are failing on account of the dry weather of summer. For sheep and hog pasture or for soiling 1 bushel of peas and 1½ bushels of other grains should be sown together. On the value of oats and pea mixtures for forage see *Oats*.

Peas grown for hogs or sheep need not be threshed or run through a cutting box, but should be fed vines and all. These animals, especially sheep, are well able to do their own threshing, and it is more economical.

For a further account of the feeding value of peas see under *Sheep* and *Hogs*.

The great value of peas in the economy of Northern farms is but little understood by the farmers of those sections.

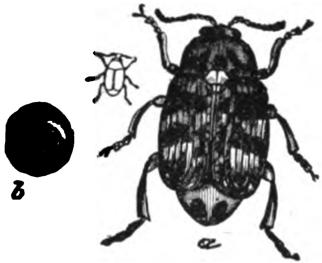


Fig. 192—PEA WEEVIL

Peas should have a place in the rotation on every stock farm in the Northern States not only because they furnish one of the best grains for both fattening and growing animals, but because they will grow in districts too cold and uncertain for corn. They furnish an abundance of excellent pasturage and cured forage almost equal to clover, are not exacting as to methods of soil preparation or time of seeding, and a crop can be removed from the soil and still leave it richer in the fertilizer element nitrogen than when the peas were planted. They thus enrich the land and fit it for succeeding grain crops, while furnishing in themselves one of the best grain and forage crops that can be grown on the more northern stock farms either for fattening or maintaining animals.

Garden Peas—Garden peas require a good, well-worked garden soil. Well-rotted barnyard manure and ashes are the most suitable fertilizers, but if the ground has been well fertilized with barnyard manure the preceding season no more need be added. Plant as early in spring as the ground can be worked, the early dwarf forms in rows about 8 to 10 inches apart, leaving a wide row for gathering about every fourth row, and the late tall growing varieties in rows 6 to 8 inches apart, leaving about 3 to 3½ feet between each 2 rows. About 1 quart of seed is needed to plant 100 feet of row. The dwarf forms do not need trellising, but the later sorts will need support. Brush stuck in between the 2 closely planted rows makes one of the best supports. But little attention beyond shallow cultivation and brushing is required. By planting at intervals of 2 or 3 weeks and by using early, medium or late varieties a succession of peas throughout the season may be obtained.

Peas are sometimes classified into smooth and wrinkled sorts, and these again into dwarf, medium and tall growing, or early, medium and late varieties. The wrinkled sorts are generally a little later than the smooth varieties, but are much superior in quality. Of the early dwarf wrinkled sorts the New Jersey Station recommends Exonian and Station; and of the medium and late half dwarf and tall wrinkled varieties Advance, Admiral, Bliss Abundance, Bliss Everbearing, Yorkshire Hero, Stratagem Improved, Queen and Heroine. Among the late half dwarf and tall smooth varieties Pride of the Market, New Giant Pod Marrow and Melting Sugar are recommended. Good early smooth peas are Alaska, Henderson and First of All. For canning the Delaware Station states that Alaska, Blue Beauty and French Canner are most extensively grown in that State. At the New York Cornell Station Extra Early Market and Rural New Yorker have proved satisfactory for forcing.

Enemies: Powdery Mildew (*Erysiphe martii*) appears at first as fine white threads over the leaves and stems. Later numerous minute black specks are seen in the fungous weft. Sometimes infested plants are much weakened and fail to develop good plump seed. At other times, however, it seems not to cause much damage, even when the vines are badly infested. Where it is possible, spraying with Bordeaux mixture will check the disease.

Rust—See under *Bean*.

Two forms of leaf blight and black mold attack peas, but rarely to a serious degree.

WEEVIL (*Bruchus pisorum*) closely resembles the bean weevil, as seen in Fig. 192, and is of a black color, with a few white spots, one somewhat resembling the capital letter T. The eggs are laid on the pods, 1 for each pea, and the grub eats its way through the pod into the pea, where it passes the winter and emerges about planting time. Infested peas are ruined for seed purposes. Seed peas may be kept over 1 season in a closed receptacle. Beetles which emerge during this time will die. A good treatment for seed peas consists in placing them in a tight box and subjecting them to the fumes of bisulphid of carbon, applied at the rate of 1 or 2 ounces to a hundred pounds of seed. The weevils are thus destroyed and the germinating power of the seed is not injured. This treatment may be continued for 48 hours. If seed peas are thrown into water those which are infested will float upon the surface and may be easily removed. The weevils may be destroyed by subjecting seed peas to a temperature of 145° F., or by soaking the peas in boiling water for 1 minute. The germinating power of the peas is not destroyed by this treatment.

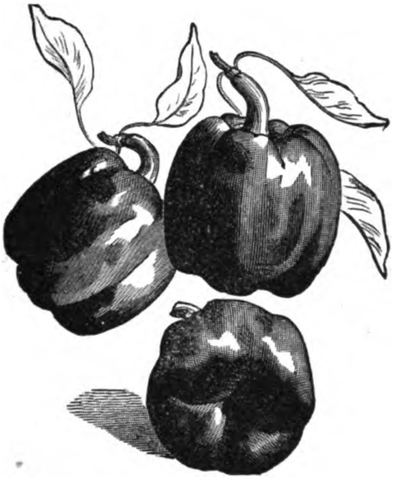


Fig. 193—LARGE BELL PEPPER

DESTRUCTIVE APHIS—See under *Plant Lice.*

Peas are also attacked by tarnished plant bug, army worm, cutworms and other pests of less importance.

PEPPERS (*Capsicum annuum*)

A vegetable grown for seasoning pickles, meat sauces, relish, etc., often referred to as red peppers, but the fruits are white, yellow, green and violet colored as well as red. The young plants are raised like tomato or eggplants. Frost injures them while they are young, but in the fall they withstand quite severe freezes. Set the plants about 2 feet apart in rows 3 feet apart. Of the varieties grown, Long Red Cayenne is one of the most pungent. Chili and Cranberry are other good varieties of this sort. For making stuffed pickles Sweet Mountain, Ruby King and Large Bell or Bull Nose (Fig. 193) are excellent varieties.

Enemies: ANTHRACNOSE appears as soft spots, which crack open on the surface of the fruit. In another form of the disease, the spots turn black. Fungicides are of little avail in the treatment of this trouble. Irrigation and mulchings are beneficial.

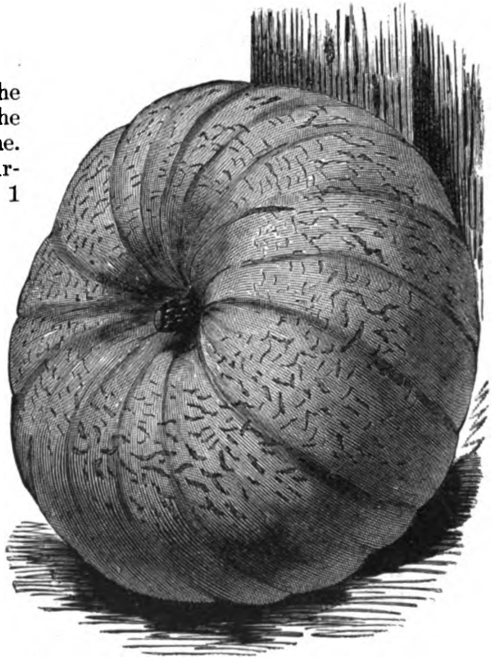


Fig. 194—CONNECTICUT FIELD PUMPKIN

BOLL WORM—See under *Cotton.*
ARMY WORM—See under *Wheat.*

PUMPKIN (*Cucurbita pepo*)

The pumpkin was formerly extensively cultivated for culinary purposes but has been supplanted in a large measure for this purpose by improved varieties of squashes. Its chief use now is as a stock food. It is a rank growing trailing plant easily injured by frost. Like melons and squashes, it thrives best on warm sandy loams. In the Northern and Central States pumpkins are quite generally grown in corn fields, a seed being placed in every third or fourth hill of every third or fourth row. Where the vines grow so rapidly as to interfere with the culture of the corn, as in some parts of the West, the seed should be planted in hills 8 to 12 feet apart each way. In such cases 6 to 8 seed should be put in each hill and 3 of the strongest plants allowed to grow. A field of well-prepared land given up exclusively to this crop pays well when rightly managed as a fall feed for cattle and pigs. Pumpkins should be broken up when fed to cattle. They may be fed either raw or cooked with meal for pigs. For dairy cows pumpkins were found equal to silage by the Vermont Station. They were cut up and fed, seed and all. No harm resulted from feeding the seed.

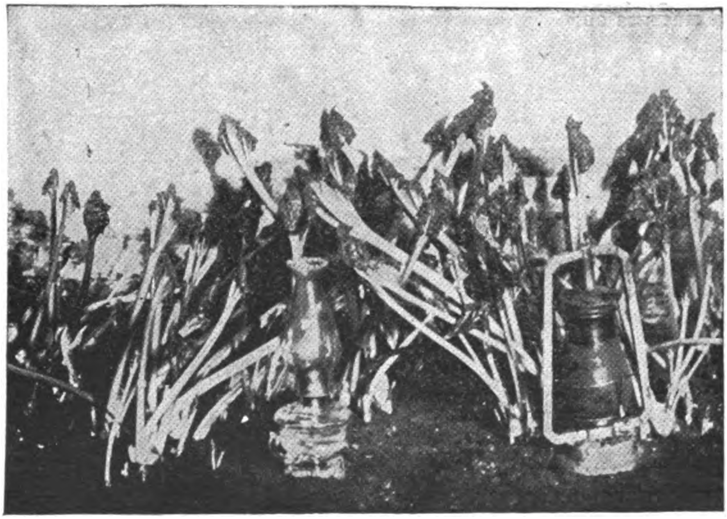


Fig. 196—RHUBARB BED IN HOUSE CELLAR

Of the various varieties of pumpkins Connecticut Field (Fig. 194) is one of the most prolific. It is a large, round, early sort excellent for stock. The Sugar pumpkin is especially valuable for pies. Canada and Cheese pumpkins are other good varieties. For feeding experiments with pumpkins see under *Cows* and *Pigs*.

For enemies see under *Muskmelon* and *Cucumber*.

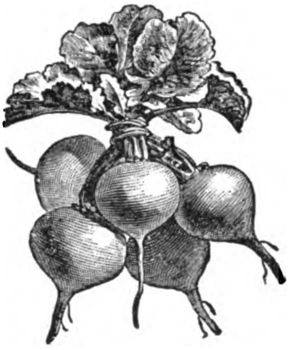


Fig. 195—SCARLET SHORT TOP RADISH

RADISH (*Raphanus sativus*)

The radish is primarily a hardy, quick-growing, early season garden crop. It requires rather cool weather for its best development and growth must be continuous from start to finish to secure tender radishes. The crop is well suited to hotbed culture in early spring, and is also a popular greenhouse crop. For family use sow large, heavy seed in clean, rich garden soil as early in the spring as the ground can be worked and every 10 days thereafter as long as desired. The roots will be large enough for the table in 4 to 6 weeks from the time of planting. Sow in rows 6 to 12 inches apart and cover ½ inch deep. Drop 2 or 3 seed to each inch of row. One ounce of seed is sufficient for 100 feet of row, or from 8 to 10 pounds per acre.

Radishes are likely to be stringy and tough when grown in hot summer weather. Winter radishes are grown like turnips are and should be planted the latter part of July or first of August.

These winter radishes are firm and tender and keep well over winter stored in the cellar or in pits. They are not as much grown as their merits deserve.

There are many varieties of radishes, differing from each other in form, size, color and taste. French Breakfast is one of the best early varieties and the most popular market sort. Other good early varieties are Scarlet Short Top (Fig. 195), Chartier and Wood Early Frame. For summer Strasburg, White Naples and White Vienna are recommended. Black Spanish, White Spanish and Scarlet Chinese are good winter kinds.

For enemies see under *Cabbage*.

RHUBARB (*Rheum rhaponticum*)

Also called pie plant. This is hardy everywhere and one of the first sauce and pie plants of spring. It is generally propagated by division of the fleshy roots. Pieces of roots are set in mellow soil in rows 5 feet apart and about 3 feet apart in the row. The root pieces should be set with the crowns about 4 inches below the surface of the soil. The ground should be kept well cultivated the first season and stalks may be pulled the following spring.

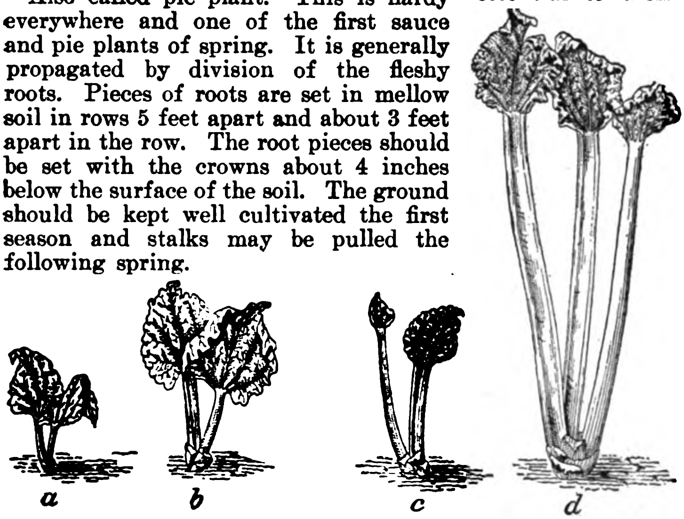


Fig. 197—FORCING RHUBARB

a, unfrozen, grown in the light; *b*, frozen, grown in the light; *c*, unfrozen, grown in darkness; *d*, frozen, grown in darkness

(R. I. Expt. Sta.)

The soil for rhubarb should be made extremely rich by the addition of an abundance of barnyard manure every other season. A good surface dressing of manure should be applied. The third or fourth year after planting the hills should be divided by cutting through them with a sharp spade and removing all the roots but 3 or 4 buds. If this is not done the buds become so numerous that only small, weak stalks are produced.

Rhubarb is also grown from seed, but varieties true to name can only be grown from roots. In growing from seed good, clean garden soil should be used and the seedlings started in beds in early spring in rows 12 inches apart and 1 inch deep. Thin the plants to stand 6 inches apart and cultivate throughout the summer. The following fall or spring they should be set out in the field in the same manner as noted for roots above. The second season stalks may be pulled freely. Eight to 12 plants will supply a big family.

Forcing in the Cellar—Rhubarb can be easily forced in the farmhouse cellar in winter and the stalks had 6 weeks to 2 months earlier than usual. Experiments at the Rhode Island Station show that for this purpose rhubarb roots should be dug late in the fall and allowed to freeze. They should then be removed to a frost proof cellar and buried 3 or 4 inches deep in moist sand. Light is not essential to their growth. In fact, in the station experiments the plants grew better in darkness than in light, as seen in Fig. 197. It is very essential that the plants should be frozen. If the room occupied by the roots is small a lighted lantern kept near them will give out heat enough to considerably hasten their growth. (Fig. 196.) Rhubarb is also forced to a considerable extent for market in special houses, cold frames, under the benches in greenhouses, etc. Forced stalks of Victoria rhubarb, ready for market, are seen in Fig. 198. For complete information on forcing rhubarb see "The New Rhubarb Culture," by J. E. Morse.

Enemies: RHUBARB CURCULIO (*Lixus concavus*) (Fig. 199) is a rusty colored snout beetle about ¾ inch long, which bores into rhubarb stalks, causing a fluid to exude. The beetles may be readily recognized and collected by hand, or all wild docks growing in the neighborhood of the rhubarb patch may be destroyed in July after the beetles have laid their eggs on them.

RUTABAGA (*Brassica campestris*)

Known also as Swedish turnip. A hardy biennial plant similar in nature to the turnip. The root is a large fleshy bulb and is produced the first year. The seed matures the second year. Rutabagas are used largely for stock food, and, to some extent, as a table vegetable. This is the turnip so much grown in England and Northern Europe for sheep.

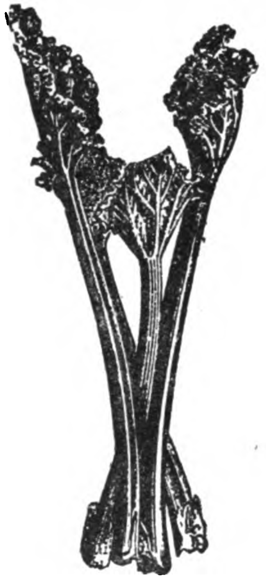


Fig. 198—FORCED STALKS OF VICTORIA RHUBARB

The rutabaga does best in rich, well-prepared loam soils. When grown for stock it should be sown from the middle of June in the Northern States to the middle of July. The seed should be drilled in rows 18 to 24 inches apart and the plants thinned to stand 6 to 10 inches in the row. From 2 to 2½ pounds of seed is required to seed an acre. The crop should be given thorough, shallow cultivation. It makes its best growth in the cool months of autumn and is not injured by frosts.

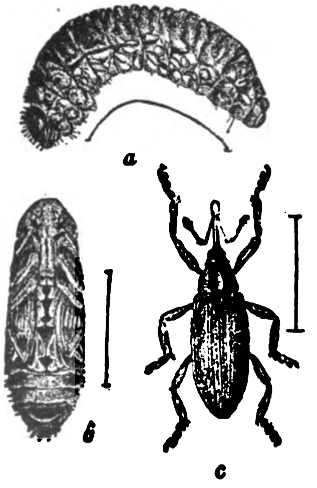


Fig. 199—RHUBARB CURCULIO
a, larva; *b*, pupa; *c*, adult

The crop should be harvested just before the ground freezes and stored either in pits, cellars or root houses. Rutabagas are easy to grow and the roots keep better than potatoes. Yields of 10 to 15 tons per acre are common. One of the best varieties is Improved American, seen in Fig. 200.

For the composition of rutabagas see *Appendix.* They are about equal in feeding value to corn silage; but it costs more to grow them. (See under *Sheep.*) Rutabagas may be sown early in spring and an early summer crop secured for the table if desired.

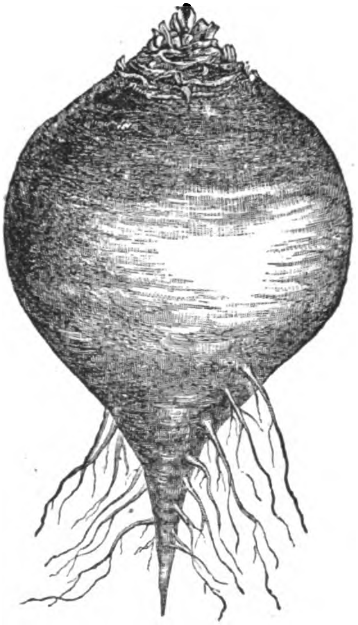


Fig. 200—IMPROVED AMERICAN RUTABAGA

For enemies see under *Cabbage.*

SAGE (*Salvia officinalis*)

A low growing perennial garden shrub (Fig. 201) the leaves of which are used for seasoning sausages, meat dressings and for other culinary purposes. It has also some medicinal value. The seed is started in a hotbed and the young plants set 10 inches apart in rows 20 inches apart in good, rich garden soil having a sunny exposure. Seed may also be sown in the open, but a cutting of leaves may not be obtained the first year. Keep clean from weeds and cut when in bloom for use. Protect in winter with a straw mulch.

SALSIFY (*Tragopogon porrifolius*)

A hardy biennial vegetable, also called vegetable oyster. The tap root is long and fleshy, resembling that of the parsnip. (Fig. 202.) The leaves have a grass-like appearance. The plant is not grown for stock. Salsify requires a deep, rich, cool soil and the whole season to mature in. Plant the seed 1 inch deep in drills about 12 inches apart and thin the young plants to 4 or 5 inches apart. Eight to 10 pounds of seed is required per acre or 1 ounce to 70 feet of drill. Keep free from weeds throughout the season. The roots may be dug and stored in late fall or left in the ground over winter. The roots when cooked have the flavor of oysters.

Fig. 201—SAGE PLANT AND FLOWER

Scorzonera or Black Salsify (*Scorzonera Hispanica*) is cultivated like salsify, as noted above. The plant, however, is a perennial, and the roots continue to enlarge if left in the ground for more than 1 season without becoming inedible. The root of this plant is black. It is used in the same way as salsify.

Scolymus or Spanish Salsify (*Scolymus Hispanicus*) is grown like salsify and used for the same purpose and in the same way. It yields considerably heavier than salsify and the oyster taste is not so pronounced.

Enemies: BACTERIAL ROT sometimes causes a complete decay of the roots and wilting of the leaves. Decayed roots are slimy and foul smelling. Attention to drainage and rotation of crops will check the trouble.

WHITE RUST may appear on the leaves and leaf stem, causing them to curl and become distorted. Affected parts should be destroyed.

Salsify is sometimes attacked by the tarnished plant bug and plant lice. (See these subjects.)

SPINACH (*Spinacia oleracea*)

An annual plant used for "greens." It is very hardy and most in demand in very early spring and late fall. The seed stalk grows about 2 feet high. The leaves are rather large and succulent. It is of very easy culture and grows best in cool weather. Quick, rapid growth is very desirable with this plant, so that the leaves and stalks may be tender. The soil should therefore be rich in humus and in fine tilth.

Culture—The seed may be sown in a hotbed or cold frame or outdoors just as early in spring as the ground can be worked. When seeded outdoors the rows should be about 12 inches apart. Sow about 40 seed to each foot of row and cover 1 inch deep. When grown for market a top dressing of nitrate of soda at the rate of 150 pounds per acre is quite generally recommended. Apply the nitrate of soda broadcast in 2 applications about 2 weeks apart soon after the plants get nicely started. The leaves will be large enough to gather in about 8 weeks. Plant at intervals of 2 or 3 weeks for a succession throughout summer and fall.

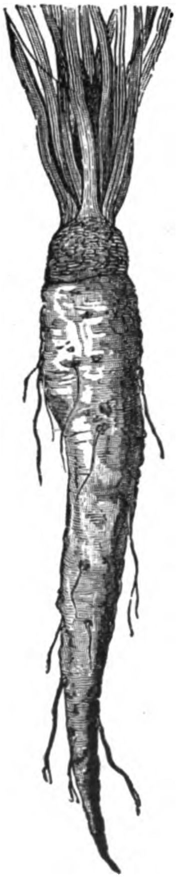


Fig. 202—SALSIFY

For the very early spring crop the seed should be sown in August or early September. On the approach of winter in the Northern States cover the crop with a couple inches of straw, leaves or other clean litter. This will generally protect the crop over winter. Very early in spring the cover should be removed. The crop grows rapidly and can soon be gathered for the table. In market gardening it is especially desirable to apply nitrate of soda to the crop in the spring, as noted above. The plants grow more rapidly and the yield is about doubled. If nitrate of soda is not available a dressing of hen manure or well-rotted barnyard manure will give good results. When thus grown over winter the spinach field should be made into slightly raised beds 6 to 9 feet wide so that water will not stand on the plants. The rows should run lengthwise of the bed. Fall sown spinach should be ready for use in April and May and the crop off the ground in early June.

Varieties—There are 2 races of spinach, the prickly seeded and the round seeded. The prickly seeded varieties are hardiest and most used for fall planting. Long Standing (Fig. 203) is considered an excellent sort for early spring and summer use. Round Leaved is a good shipping variety. Prickly or Winter is valuable for fall seeding. Bloomsdale is another excellent sort.

New Zealand Spinach (*Tetragonia expansa*) is not a spinach at all. It grows well in summer, however, and is one of the best substitutes for spinach. (See also R. I. Expt. Sta. Bul. 41.)

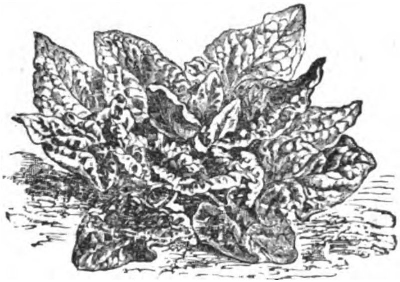


Fig. 203—LONG STANDING SPINACH

Enemies: MILDEW (*Peronospora effusa*) appears as gray, velvety patches on the under side of the leaves, with corresponding yellow spots on the upper side. It occurs also on pigweeds and lamb's quarters.

ANTHRACNOSE (*Colletotrichum spinaceae*) appears as gray spots on the leaves, containing brown pustules. The disease has no preference for the upper or under side of the leaves.

LEAF BLIGHT (*Phyllosticta chenopodii*) forms numerous minute pimples on the lower part of the leaf.

WHITE SMUT (*Entyloma Ellisii*) differs from the grain smuts in that the spores are colorless and give the leaves a frosted appearance.

BLACK MOLD (*Cladosporium macrocarpum*) occurs on old leaves as dark blotches. The disease seldom attacks young, vigorous plants.

In treating any of these diseases rotation of crops and destruction of affected plants is recommended. A mixture containing equal parts of sulphur and air-slaked lime may be raked into the bed before planting.

Spinach is usually free from insect pests, but may be attacked by the leaf maggot (*Pegomyia vicina*). The eggs are deposited on the under side of the leaves and the larva mines in the tissue of the leaf. The mine soon resembles a blister. The insect feeds on spinach, beets and weeds such as lamb's quarters. These weeds should be destroyed in the neighborhood of spinach and beet fields. Deep, early spring or late fall plowing, followed by rolling, is recommended.

SQUASH (*Cucurbita* spp.)

This term includes also what are sometimes called pumpkins. According to Bailey, what are called summer squashes belong mostly to varieties of *C. pepo,* and the winter squashes to *C. maxima* or *C. moschata,* but chiefly to the former. Squashes are grown as a table vegetable and for making pies.

Squashes, like cucumbers and melons, require a warm, fertile soil of a sandy nature for their best growth. Summer squashes grow mostly in compact bush forms. The hills for these should be about 4 feet apart, and for the long trailing fall and winter varieties 8 to 12 feet each way. The hills should be 12 to 18 inches across, and if the ground is not already rich 2 or 3 shovels of well-rotted manure should be worked into it. Frost easily kills the plants, and the seed should not be sown outdoors until the ground is warm and the weather settled. Put 8 to 10 seed in each hill and cover 1 inch deep, firming the soil down with the hoe afterward. When danger from bugs is past thin the hills to 3 or 4 of the strongest plants.

The male and female flowers of the squash are separate on the same vine, and in some of the newer prairie sections where insects are not abundant it may be necessary to hand pollinate the flowers. This is done by dusting the pollen of the male flowers on the stigmas of the female flowers.

Harvesting—Summer squashes are cooked and eaten whole before the skin hardens. Winter squashes may also be eaten in a green state, but are not stored for winter use until the skin has hardened. Winter squashes should be gathered as soon as fall frosts threaten. Leave on about an inch of the stem and let the squashes lie in the sun for a few days, covering at night with vines and other litter to protect them from frosts until the skin is hard and flinty, then store in dry rooms having a temperature of about 50° F. Care must be observed not to bruise the skins or they will not keep well. Store in tiers not more than 2 deep.

Varieties—Summer Crookneck is an excellent summer sort. Bush Scalloped is a popular market gardening sort. Of autumn varieties Boston Marrow is one of the best. (Fig. 204.) The best known and most largely grown winter variety is Hubbard. (Fig. 205.) This has a rough, hard shell and is one of the best winter keepers. Marblehead is another excellent winter variety, as are also Essex Hybrid and Bay State. Winter or Canada Crookneck is an excellent pie sort.

Enemies: FUNGOUS DISEASES—See under *Cucumber* and *Muskmelon.*

VINE BORER (*Melittia satyriniformis*) attacks the squash by boring holes through the stems to the inside, where galleries of considerable length are made. The vines wilt or appear sickly, in many cases being killed outright. The larva is a soft-bodied white caterpillar, about 1¼ inches long. The adult is a clear-winged moth, of a light brown color, with metallic green reflections. The eggs are laid for the most part on the stems. In badly infested localities rotation of crops is advisable. Late harrowing is sometimes effective, since the chrysalids pass the winter in the soil. Deep plowing in the spring will bury them so that they will not be able to escape. The larvae may be removed with a knife, and their presence may be detected by dust-like debris on the ground beneath the stems.

SQUASH BUG (*Anasa tristis*) is a bug ¾ of an inch in length, of a brown or black color, mottled with yellow below. The young resemble the adults, except for the absence of wings and a lighter gray coloring. The insect passes the winter in the adult condition under rubbish or stones. Eggs are laid in the spring on the under side of the leaves. The bug is injurious in its immature and adult stages. The first brood may be collected from the vines in the spring and dropped into pans containing water covered with a film of kerosene. The eggs are readily detected and should be destroyed. Clean culture is of importance, and the squash vines should be destroyed immediately after harvest, together with all rubbish that may remain in the squash fields.

For other insect pests see under *Cucumber.*

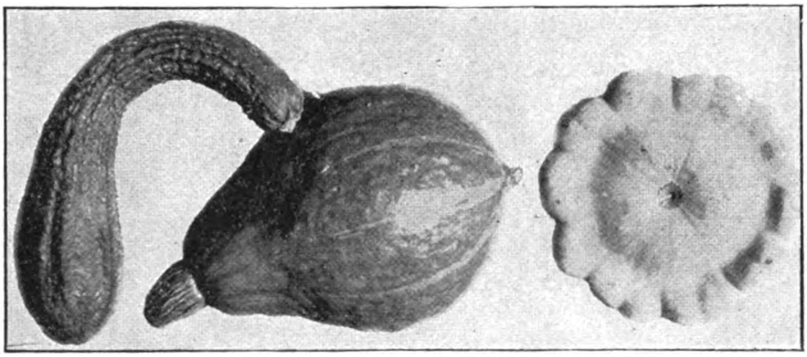


Fig. 204—VARIETIES OF SUMMER SQUASHES
("Vegetable Gardening," S. B. Green)

SWEET CORN (*Zea Mays saccharata*)

Grown primarily as a garden vegetable, though sometimes for silage or for feeding green. The dry seed usually has a wrinkled appearance. The corn is used as a vegetable and for canning when the kernels are well filled and plump, but still soft and milky. The crop is peculiarly adapted for culture in the Northern States and Canada; in the South is is not so much grown and does not retain its peculiar characteristics. If grown, seed must be obtained each year from the North. Sweet corn is sometimes grown in the greenhouse late in the spring, but this practice is rare. (See N. H. Expt. Sta. Bul. 60 on growing green corn under glass.)

Sweet corn is grown and cultivated like field corn (see *Corn*), except that as a horticultural crop it requires more intensive culture. It should be given a rich, warm, loamy soil that has been well prepared by thorough cultivation and heavy fertilizing with well-rotted barnyard manure. The earlier the crop is put on the market the better will be the prices realized. Some risk, therefore, should be taken in putting the seed in early. Plenty of seed should be used, for if the weather is backward much of it is likely to rot. For the early crop some quick-acting nitrogenous fertilizer to furnish immediate available plant food should be used in addition to barnyard manure. In a test at the New Jersey Station the average yield of sweet corn was increased 21 per cent by the use of nitrate of soda, 25 per cent when sulphate of ammonia was used, and 35 per cent when dried blood was used. Other features of the test showed that it is advisable to use an abundance of all forms of fertilizers for sweet corn.

Planting and Cultivation—The early crop should be put in at the earliest moment after danger from frost is past. Other plantings may be made at intervals of a week to 10 days thereafter to afford a succession until late fall. It may be planted either in hills or drills. When planted in hills cultivation may be practiced both ways. The hills should be about 3 feet apart each way. About 6 kernels, which will furnish 3 to 5 stalks, should be put in each hill. If planted in drills the rows should be 3½ feet apart and the stalks stand 10 to 12 inches distant in the row. It requires about 8 quarts of seed to plant an acre. Shallow cultivation should be practiced to preserve the moisture of the soil, since this crop requires a large amount of water in its growth and is likely to suffer from drouth.

Harvesting—The corn is gathered for market by breaking off the green ears with the husks on. It is usually sold by the dozen. The price ranges from 25 cents per dozen for the early crop to 5 cents for later crops. Corn for canning purposes is usually grown by contract and sold for $8 to $12 per ton after all imperfect ears have been removed and allowance made for extra husks. The stalks remaining after the corn is removed are in excellent condition for fodder. For home use green corn can be preserved by cutting the kernels from the cob and drying in the sun.

Varieties—Corey (Fig. 206) is one of the best very early varieties. It matures in about 60 days. Crosby is a good second early variety. For the main crop Stowell Evergreen is the standard sort. Other excellent varieties are Country Gentleman, Hickox Improved and Egyptian. For canning purposes Stowell Evergreen and Country Gentleman are very desirable sorts.

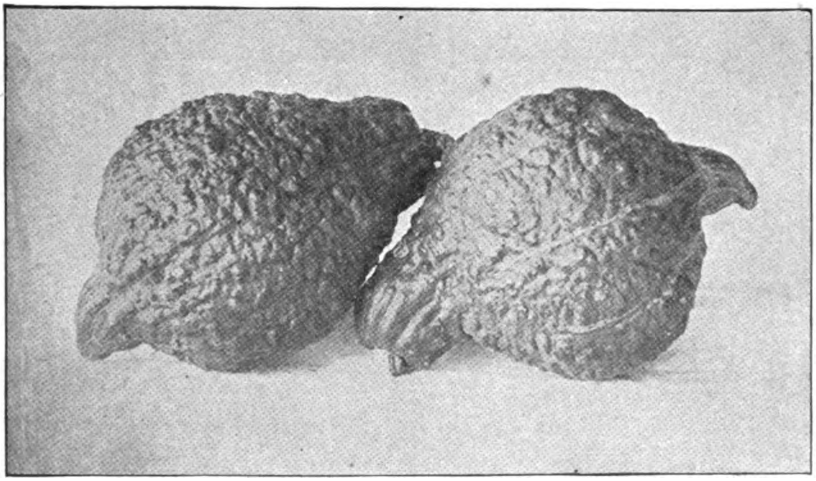


Fig. 205—HUBBARD SQUASH
("Vegetable Gardening," S. B. Green)

SWEET POTATO (*Ipomoea batatas*)

The sweet potato plant is a low trailing vine that produces edible tuberous roots. (Fig. 207.) About 50,000,000 bushels of sweet potatoes are grown annually in the United States. They are used like potatoes as a table vegetable and for feeding to stock. The plant is probably native to tropical America. It is tender to frost and not grown commercially to any extent north of New Jersey. In gardens it is grown as far north as Maine and Michigan. It is extensively grown all through the South and in California. The chief States of production are the Carolinas, Georgia, Texas, Alabama, Mississippi, Virginia and New Jersey.

Propagation—Sweet potatoes are propagated from sets or shoots which spring from the tubers when they are planted, and from cuttings taken from the tips of the runners. The sets are obtained by planting the potatoes in a hotbed, frame or structure furnishing artificial bottom heat. The layer of manure under the hotbed in the North should be 8 to 12 inches thick. In the South a layer 2 to 5 inches will be sufficient. The temperature of the bed should be from 75° to 80° F. A layer of sand or soil 1 to 3 inches thick is placed over the manure. The tubers are placed in a single layer on the sand close together but not touching, and covered 2 to 3 inches deep with soil. Small tubers appear to be just as good for the production of sets as large or medium sized ones. If large tubers are used they should be cut lengthwise and placed in the bed cut side down.

The roots should be bedded 5 or 6 weeks before the sets are wanted for planting out. The sets are broken from the potatoes for transplanting when they are 3 or 4 inches high, and others form in their places, so that in all 2 to 4 "draws" or crops of sets are obtained. A bushel of medium sized sweet potatoes will produce from 3000 to 5000 sets if they are removed twice. It requires from 5000 to 10,000 sets to plant out an acre, so that the amount of seed required per acre will vary from 1½ to 4 bushels. For the late plantings, cuttings 12 to 14 inches long taken from the young vines after they have started growth may be used. It requires from 90 to 100 days for a crop to mature from vine cuttings. As good crops are produced as from sets.

Soil and Fertilizers—The sweet potato grows best on a warm, fertile, sandy soil; but all soils are used, including clays. Sticky or colored soils injure the appearance of the roots for marketing, and should be avoided. The soil should be put in good condition by fertilizing with well-rotted barnyard manure. This should be supplemented with commercial fertilizers when the crop is grown for market. Starnes recommends a formula composed of 640 pounds high grade acid phosphate, 260 pounds nitrate of soda and 100 pounds sulphate of potash. This should be mixed and applied at the rate of 1000 pounds per acre. Where barnyard manure is not available or too expensive, the ground can be put in good condition by plowing under green crops like crimson clover, peas, etc. Dried blood and cottonseed meal have been found preferable to nitrate of soda in many localities. On soils well supplied with organic matter nitrogen in the fertilizers applied may be omitted, but potash is especially desirable, and phosphoric acid in a less degree.

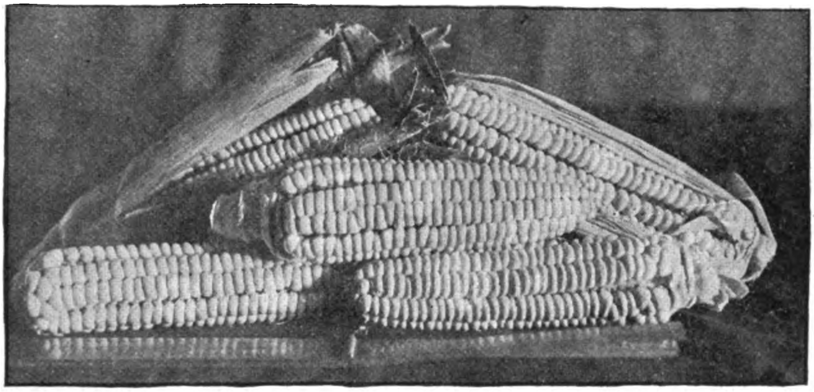


Fig. 206—EARLY COREY CORN
("Vegetable Gardening," S. B. Green)

The soil should be well prepared before the sets are put out. Truck farmers on sandy soils usually plow but 3 or 4 inches deep for the early crop, claiming that they get short, better shaped potatoes thereby, but the heaviest yields are obtained by deeper preparation.

Transplanting and Cultivation—The sets or cuttings are put out in rows about 3 feet apart and the plants spaced 18 inches in the row. Most growers plant sweet potatoes on ridges 2 to 12 inches high. It is believed the ridges warm up sooner than the flat earth and thus start the crop off more promptly. They are made by throwing 2 furrows together with a turning plow or like implement. The sets may either be put in by hand or with a planter. Cuttings are prepared by removing all the leaves except the top. They are laid in the rows in a nearly horizontal position with only the tips exposed. Roots are readily sent out from the joints. Cultivation consists of 2 to 4 harrowings, and possibly 1 or 2 hoeings. The vines root at the joints and some growers lift them from time to time after the last cultivation, but the practice is not financially profitable nor advisable.

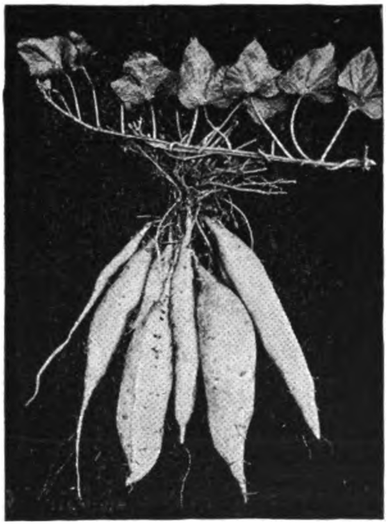


Fig. 207—SWEET POTATO TUBERS AND VINE
("Vegetable Gardening," S. B. Green)

Harvesting and Storing—Sweet potatoes may be gathered for the table as soon as they are large enough. The main crop should be left in the ground until the tubers mature. This is told by breaking the tubers and exposing them to the air. If they are mature enough for storing the original color is maintained, if not the broken surface turns a black or greenish color. In any case they should be gathered immediately after the first frost. Before digging the vines are cut and cleared away and the tubers then dug with a hill sweep plow or like tool. After drying in the sun for a few hours they are gathered into small piles, where they remain until removed from the field. (Fig. 208.)

Sweet potatoes do not keep long under the best methods of handling and the most efficient method of storage is still an unsettled one. Large handlers store them in dry rooms having good ventilation and keep the temperature at from 50° to 65° F. When the tubers are first put in storage and are going through the sweating period the temperature is run up to 80° F. The common method of storage is to put the tubers in a cone shaped pile containing 30 to 50 bushels. Over the pile a layer of dry fine straw or hay, then a layer of cornstalks, and on top of this 2 or 3 inches of dry sand is placed. The whole is then banked 2 or 3 inches deep with heavier soil.

At the South Carolina Station sweet potatoes stored in cottonseed hulls and in dry sand kept very well. A good crop of sweet potatoes will run from 200 to 400 bushels per acre. The cost of production is about $20 per acre.

Varieties—In the South a soft, sugary sweet potato is most in demand; Northern consumers require a firm, dry, mealy potato. Popular varieties in the South are Sugar Yam, Spanish, Barbadoes, Georgia, Hayman and Pumpkin. In New Jersey, Jersey and Yellow Nansemond are extensively grown. Other popular varieties for Northern markets are Early Carolina, Red Nansemond and Red Nose. Various varieties of vineless or bush forms of the sweet potato are becoming popular with growers. The word "yam," as commonly used, refers to varieties of sweet potatoes. The true yam belongs to the *Dioscorea* genus of plants and is seldom ever grown in this country.

Uses—Sweet potatoes are used as a table vegetable, for pies and canning. In some localities the crop is extensively grown for stock. Hogs relish them and do their own digging. For cattle and horses the roots should be sliced. Sweet potatoes contain 4 to 6 per cent of sugar and 16 to 18 per cent of starch. They contain considerably more fat than Irish potatoes, and, on the whole, have a somewhat greater food value. (See *Appendix.*)

For feeding experiments see under *Pigs.*

Literature—U. S. Dept. Agr. Farmers' Buls. 26 and 129; S. C. Expt. Sta. Bul. 63; Ark. Expt. Sta. Bul. 72; "Sweet Potato Culture," by James Fitz, and "Sweet Potato Culture for Profit," by R. H. Price.

Enemies: Black Rot (*Ceratocystis fimbriata*) appears on the roots as dark brown or green spots, which enlarge after the roots are stored. The spots become sunken areas and the roots undergo dry rot. The young sprouts may be attacked in the same manner. Affected roots should not be used for seed, but should be collected and destroyed. The soil of hotbeds may be heated to a high temperature so as to destroy the fungous parasites.

Fig. 208—HARVESTING SWEET POTATOES

Soil Rot (*Acrocystis batatas*) attacks young roots and is most injurious in dry seasons. Affected parts cease growing and diseased roots show striking constrictions. The disease does not progress after the root is mature. Rotation of crops is recommended. In New Jersey sulphur or kainit at the rate of 300 pounds per acre was found to check the development of soil rot.

Stem Rot—See under *Eggplant.*

Soft Rot (*Rhizopus nigricans*) appears during the period of sweating, a few weeks after harvesting. All diseased potatoes should be picked out and destroyed and all potatoes should be thoroughly dry before storing.

Sweet potatoes are also affected by dry rot, white rot, leaf spot, scab and white rust. With the exception of the white rust, the last named diseases are not very serious. White rust lives also on wild morning glory, which should not be allowed to grow near sweet potato fields.

Weevil (*Cylas formicarius*) is ¼ of an inch long, of a bluish black color, with a red thorax. The eggs are laid in cavities at the base of the vine or at the stem end of the root. The white grubs upon hatching burrow in the vine and later descend to the roots, which they destroy by burrowing. The only effective method for combating this insect consists in the removal of all badly infested roots and feeding them to hogs or other animals. Infested vines should also be destroyed.

Sweet potatoes are often attacked by cutworms, flea beetles, tobacco worm and crickets. (See these subjects.)

Tortoise Beetles of a number of species feed upon the leaves of the sweet potato. These beetles may be recognized by their bright gold, green or iridescent colors, hemispherical shape and protruding, flattened margins. Since these beetles are most injurious soon after the plants are set, it is recommended that plants be dipped in a solution of arsenate of lead (2 pounds to 50 gallons) before setting. This treatment will be found effective for tortoise beetles and flea beetles on sweet potatoes. Paris green in the proportion of ¼ pound to 40 gallons of water, to which ¼ pound of lime is added, will also be found effective. The same remedies may be used against sawflies, which depredate on sweet potatoes.

Plume Moth (*Pterophorus monodactylus*) is silvery brown in color, with black streaks on the forewings. The larva of this species is green in color, with a dark stripe along the center of the back. The larvae feed upon leaves. They may be destroyed by spraying with arsenicals, as recommended for tortoise beetles.

TEA (*Camellia theifera*)

Experiments at Pinehurst, S. C., where a plantation of 50 acres of tea is being successfully grown, indicate that under proper conditions tea may be made a profitable industry in some portions of the South. It requires a moist climate and the temperature should not frequently fall below 25° F.

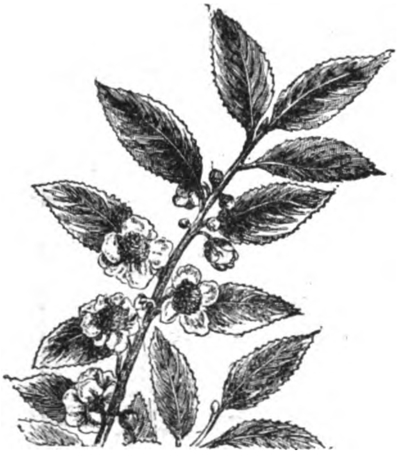


Fig. 209—FLOWERS AND FOLIAGE OF THE TEA PLANT

A flowering branch of the tea plant is shown in Fig. 209.

Tea is propagated from seed grown first in a nursery and then transplanted when 9 to 12 inches high. The seedlings are set 4 to 5 feet apart each way in the permanent plantations. The tea of commerce is the dried, immature leaves of the tea plant. The bushes are allowed to grow about 4 feet high. They come into full bearing when about 6 years old, when they produce 75 to 100 pounds of dry tea per acre.

In the preparation of tea the leaves are first withered either in the sun or by artificial heat, then rolled to give the leaves a twisted shape, fermented to bring out the peculiar tea flavor, and then fired by spreading in thin layers and drying by artificial heat or in the sun.

The experiments at Pinehurst indicate that the cheaper grades of tea cannot be grown in this country without a protective duty, but the better grades can be profitably produced wherever the labor conditions are favorable. For home use, however, tea can be grown in nearly all Southern gardens. A complete report on tea culture at Pinehurst may be found in U. S. Dept. Agr. Rpt. 61.

TOMATO (*Lycopersicum esculentum*)

This common garden and market vegetable is grown in most parts of the United States. It is more largely used in canning than any other vegetable. The plants are branching and do not grow erect without support. It is a long season plant, sensitive to frost, but of the easiest culture. The plants are grown from seed started in a hotbed, cold frame or the kitchen window. The best seed to use is that grown in the neighborhood where the crop is to be grown. At the Ohio Station the finest and earliest fruit was obtained by using seed selected from plants giving the most and best early fruit. Growers should save their own seed each year, as varieties of tomatoes quickly run out unless the seed is selected with great care.

Starting the Plants—The tomato plants should be started early. In the Northern States the seed should be sown by March 15 and in the South considerably earlier. The seedbed should be of good loam, rich in vegetable matter. If grown in the greenhouse or hotbed the seed should be sown in rows 6 inches apart, putting about 4 seed to the inch and covering ½ inch deep. Where only a few plants are wanted for family use a pinch of seed may be sown broadcast in a box filled with good soil and kept in the kitchen window. Under favorable conditions the young plants appear in 8 to 10 days after seeding. They should be given plenty of light and kept constantly growing. Strong, stocky plants are essential to the earliest crops and heaviest yields. Nearly all the station experiments agree in showing that the seedlings should be transplanted at least once before they are set in the field. The plants are usually ready for transplanting within a month or 6 weeks after they come up. They may be set 4 to 5 inches apart each way in a cold frame or transplanted in old berry boxes, tin cans or pots. In any case they should have a good layer of well-rotted manure under them and be set in rich soil. After transplanting the plants should be given plenty of air and sunshine and be well hardened off before setting in the field. Good, strong plants ready to set in the field should be 12 to 15 inches high, with a strong stem, numerous side branches and a number of crown blossoms.

Soil and Fertilizers—A rich, warm, sandy loam soil is best for the early crop of tomatoes. When the crop is grown for canneries a medium clay loam will give larger yields. Any good potato soil will also produce a good crop of tomatoes. From the results secured at the stations it is shown that heavy applications of stable manure or complete fertilizers are very desirable for this crop. The tomato particularly demands large amounts of potash and nitrogen. Stable manure is essentially a nitrogenous manure and should be supplemented with heavy applications of muriate of potash, ashes, kainit or like potash fertilizers and a smaller amount of acid phosphate or ground bone to supply phosphoric acid. Voorhees recommends for soils already in good condition a mixture of 400 pounds nitrate of soda, 700 pounds bone tankage, 400 pounds acid phosphate and 500 pounds muriate of potash applied at the rate of 500 pounds per acre. In the field culture of tomatoes it is desirable that they follow some well-manured crop, especially a hoed crop or clover.

The ground for tomatoes should be prepared early either by fall or early spring plowing and put in fine tilth. The plants should be set in the field just as soon as danger from frost is past. On rich garden soil the plants are set 4 to 5 feet apart each way and 6 inches deep; in field culture they are put 3 to 4 feet apart each way. When set 3 by 4 feet it requires 3630 plants per acre. An ounce of seed will produce 2000 to 2500 plants.

Field Culture—In field culture the crop is horse-cultivated and the plants allowed to spread out on the ground at will. In the North, where early frosts occur, it may be advisable to prune off a foot or more of the growing shoots some time in August to hasten the maturity of the crop. A light mulch of hay, straw or like material is sometimes put under the plants to keep the fruit off the ground. At the New Jersey Station mulching also increased the yield 12 per cent. The Nebraska Station also reports very good results from mulching tomatoes. In garden culture and in the greenhouse tomatoes are usually trained to stakes or wires. In outdoor culture the Michigan Station found a pair of wires fastened to each edge of a 6-inch fence board a very serviceable form of trellis for tomatoes. When tomatoes are trained to stakes 1 stake 6 feet high is used for each vine and the vine pruned to 1 to 3 stems. (Fig. 210.) Pruning to a single stem is generally recommended. The object of pruning is to increase the size of the individual fruits and the earliness of the crop.

In harvesting the early crop of tomatoes only smooth, bright, medium-sized fruits, not too ripe, should be marketed.

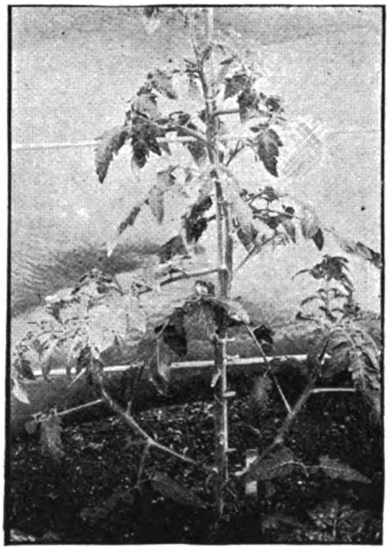


Fig. 210—TOMATOES THREE-STEM TRAINING (N. Y. State Expt. Sta.)

Illinois shippers use a 1-3-bushel box for marketing this fruit. Florida shippers use the 6-basket carrier and wrap each fruit in some bright-colored paper. In New Jersey either a basket holding 5/8 of a bushel or crate holding 3/4 of a bushel is used. Tomatoes are easily injured in handling and great care should be used in selecting only sound specimens for market.

In the Northern States, where early fall frosts are likely to cut off the crop, the tomato season can be lengthened by picking off the larger green fruits and placing them in some dry, shady place. The vines then, with the smaller immature fruits, should be pulled up and hung in a shed or other dry place. The fruit is frequently able to draw enough nourishment from the stems to fill out and ripen.

Early Tomatoes—In the field culture of early tomatoes the plants are grown as noted above, and planted out on light, well-drained sandy loams which have been previously heavily manured for other crops. The secret in the growing of the early crop is to use strong, sturdy plants and to fertilize the vines with nitrate of soda, providing the soil is already well supplied with phosphoric acid and potash. Extended experiments in New Jersey and New York indicate that 160 to 200 pounds of nitrate of soda is about the right amount for 1 acre of plants. Half the nitrate should be applied at the time the plants are set and the other half 3 or 4 weeks later. A handful of the nitrate is applied around each hill, but not brought in contact with the roots. This supply of immediately available food tends to start the plants off promptly so that no check in growth occurs. As it is rapidly used up no late growth of vine is encouraged, as might be the case with slower acting fertilizers, and a large yield of fruit results. Tests in Delaware, Maryland and New Jersey indicate that nitrate of soda is the best single fertilizer for tomatoes on soils already well supplied with the other essential elements. On poorer soils 400 pounds of acid phosphate and 200 pounds of muriate of potash should be worked into the soil before the plants are set, and liberal applications of well-rotted stable manure made.

Early tomatoes yield all the way from 100 to 500 bushels per acre, the average under good culture being not far from 250 bushels. The late crop grown for canneries will average about 8 tons of fruit per acre. The range is from 5 to 20 tons per acre. A ton of fruit will produce from 380 to 400 cans.

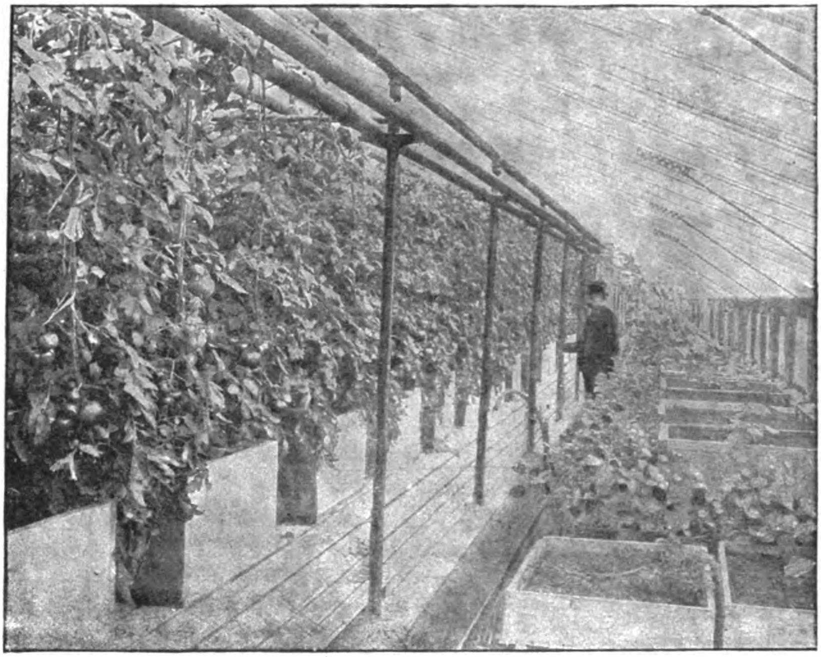


Fig. 211—A TOMATO FORCING HOUSE

Culture Under Glass—Tomatoes are extensively forced under glass. Special houses are often devoted to this work, but usually the crop is grown in late winter or early spring after some other crop. The house is kept at a temperature of 60 to 65° F. at night and 10° higher in the daytime. The plants are preferably grown on benches in 7 to 8 inches of soil. The rows are about 24 inches apart and the plants grown 18 inches apart and trained 5 to 6 feet high to a single stem. Hand pollination is practiced. The yield obtained averages about 1 pound of fruit for each square foot of bench. The price ranges from 10 to 50 cents per pound. The houses are so managed that the first fruits are obtained during the holidays. Usually 1 winter crop and 1 spring crop are grown, and the fruit continues to ripen for a period of 8 to 10 weeks in each case. A successfully managed tomato forcing house is seen in Fig. 211. Detailed directions for forcing tomatoes may be found in "The Forcing Book," by Bailey, and "Greenhouse Management," by Taft. (See also N. H. Expt. Sta. Bul. 84; N. J. Expt. Sta. Bul. 141; N. Y. State Expt. Sta. Bul. 125, and the Reports of the Conn. State Expt. Sta. since 1891.)

Varieties—Not much dependence can be put in the name of a tomato, since the varieties degenerate so rapidly. In general, varieties with large, smooth, solid fruits that ripen to the stem should be chosen. Some of the better field varieties are Stone, Paragon, Livingston, Perfection, Favorite and Beauty. At the Maryland Station some of the largest early yields were made by Early Ruby, Potato Leaf, Prize Taker, Autocrat and Canada Victor. The Minnesota Station found Acme, Dwarf Champion and Beauty most desirable. Some of the best varieties for forcing in the greenhouse are Lorillard, Chemin Market, Optimist and Ithaca. The first is the variety most largely used. Practically every station has reported the results of variety tests with tomatoes, and the reader is referred to these for further notes along this line.

Literature—Some of the more valuable general bulletins on tomatoes are as follows: Ala. Expt. Sta. Bul. 108; Iowa Expt. Sta. Bul. 47; N. Y. Cornell Expt. Sta. Bul. 32; N. J. Expt. Sta. Bul. 136; U. S. Dept. Agr. Farmers' Bul. 76.

Enemies: LEAF BLIGHT causes the leaves to turn brown and dry up soon after the fruit begins to ripen. The disease attacks both early and late tomatoes. It may be checked by spraying with Bordeaux mixture every 10 days until the fruit begins to ripen, when ammoniacal solution of copper carbonate may be used.

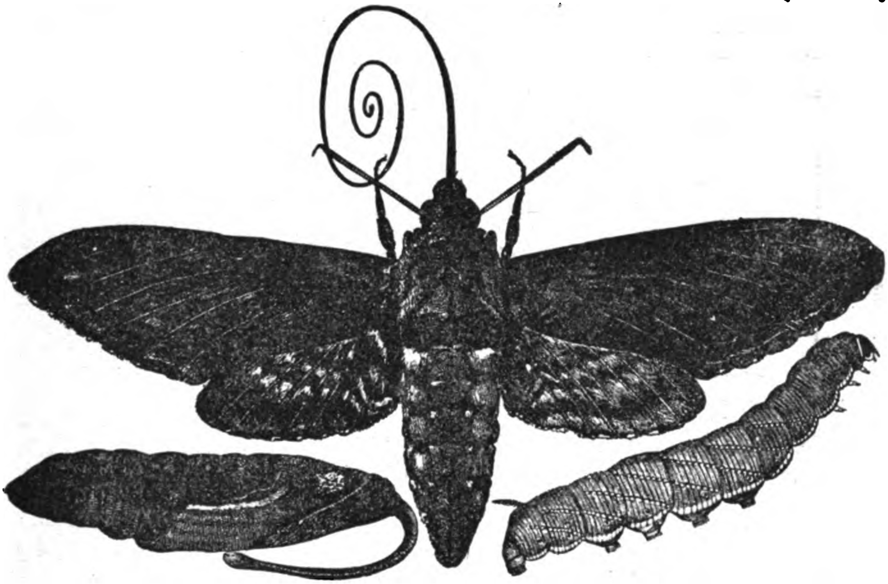


Fig. 212—**TOMATO WORM OF THE NORTH**
The Sphinx moth, pupa and caterpillar

LEAF SPOT (*Septoria lycopersici*) appears as numerous small irregular brown spots on the leaves. The disease is easily controlled with Bordeaux mixture.

BROWN ROT, DOWNY MILDEW and LEAF BLIGHT—See under *Potato.*

SCAB (*Cladosporium fulvum*) forms greenish-brown velvety patches on the lower side of the leaves, causing the latter to turn yellow and drop off. It is most dangerous in wet weather. The disease yields readily to treatment with Bordeaux mixture.

Blight appears as a sudden wilting of the plants. The small roots decay and the larger ones are covered with a fungous weft, in which small brown bodies are formed. Diseased plants should be dug up and destroyed. Bordeaux mixture may help to check the disease.

Fruit Rot is a bacterial disease, which first appears as a watery spot near the blossom end of the fruit. Growth ceases in the affected spot and a sunken area is formed. Diseased fruits are ruined. Bordeaux mixture is of no avail against the disease. It is probably carried by insects, especially thrips, and remedial measures should look toward the destruction of insect pests.

Tomatoes are also subject to an anthracnose which yields to treatment with Bordeaux mixture.

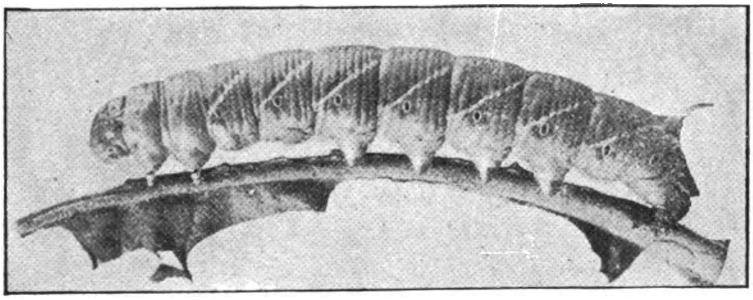


Fig. 213—LARVA OF THE SOUTHERN TOBACCO WORM
(Fla. Expt. Sta. Bul. 48)

Tobacco Horn Worms or Tomato Worms (*Protoparce Carolina* and *P. celeus*) are large caterpillars of sphinx moths, which eat the leaves of tobacco, tomatoes and other related plants. Fig. 212 shows the Northern species, and Fig. 213 the caterpillar of the Southern kind. These caterpillars bear a stout curved horn on the posterior end of the body, the horn being red on the first species and black on the second. The adult insects are large gray moths, the first species being darker in color. The habits and life history of the 2 species are almost the same, and for practical purposes they may be considered together. The relative abundance of the 2 species varies considerably in different parts of the country. There are 2 or 3 generations, according to the latitude, and, in some localities, a fourth. The caterpillars of both species are subject to bacterial diseases and are often destroyed in large numbers by this cause. When they are abundant the caterpillars may be destroyed by hand-picking or by application of Paris green.

Bollworm—See under *Cotton.*

Flea Beetle—See under *Flea Beetles.*

A mite disease of tomatoes has been reported as causing a peculiar gall formation on the leaves, consisting of numerous threads appearing like mildew. In greenhouses this trouble may be prevented by fumigation with sulphur. Out of doors the disease is usually not very serious. Tomatoes are also attacked by the buffalo tree hopper, blister beetles and nematodes.

TURNIP (*Brassica rapa*)

The turnip is chiefly grown in the United States as a table vegetable and only in limited amounts for stock. As a stock food it is about on a par with rutabagas, beets or silage, but cannot be so cheaply grown as silage. In garden culture the seed may be sown either very early in spring and an early summer crop secured, or later in July and August for winter storing. The plant is not easily injured by frost and makes its best growth in cool, moist weather. For early use plant in rows 1 to 1½ inches deep and 12 to 18 inches apart. The plants are thinned to stand 4 to 8 inches apart in the row, depending on the varieties grown. In field culture the rows are often 30 inches apart to facilitate horse cultivation. The seed is sometimes sown broadcast from July 20 to August 1, when the crop is grown for stock. Two to 3 pounds of seed are required per acre. The crop is harvested upon the approach of freezing weather, the tops cut off and the roots stored either in pits or cellars. They sprout readily and should be kept as cool and dry as possible. A yield of 1000 bushels per acre is sometimes obtained on rich land.

Varieties—The Globe varieties are considered best for the main crop and for fall and winter use. Some of the best garden varieties are Early Flat Dutch (Fig. 214), Purple Top and White Top Strap Leaf.

For enemies see under *Cabbage.*

WATERMELON (*Citrullus vulgaris*)

A trailing annual, sensitive to frost. It is a native of Africa, but is now more largely grown in the United States than anywhere else. It flourishes especially in the warm, sunny regions of the South and West, where it is grown extensively in a commercial way. Good watermelons for home use, and to a limited extent for market, are grown as far north as Canada.

The watermelon grows best on rich, warm, sandy loams that are well drained. If possible, a southern slope should be chosen for the early melons. It is desirable in growing watermelons for market that they follow a crop of clover or cowpeas. They should be rotated with other crops and should not be planted on the same ground again for 3 or 4 years. If the soil is poor it may be put in good condition by plowing under a heavy application of barnyard manure in the fall. The spring preparation of the land consists in thorough cultivation at intervals of 3 or 4 weeks before the seed is planted. This is for the purpose of germinating the weed seed and of putting the soil in the best possible physical condition. In Georgia the station states that rather shallow plowing, followed by thorough pulverization with the disc harrow, is practiced.

Melons should not be planted until all danger of frost is over. In States as far north as Michigan and New Hampshire this will not be before May 20 to 31. Watermelons are planted in hills usually about 10 feet apart each way. According to the New Hampshire Station, one of the most successful watermelon growers in that State digs each hill 8 to 10 inches deep and 18 to 24 inches across and fills them 2-3 full of rich, well-rotted manure. "Enough soil is drawn on this and thoroughly mixed with the compost to fill the hill nearly full. A half pint of unleached wood ashes or fine hen manure or a small handful of phosphates is sprinkled over the top soil and well mixed with it, after which enough soil is added to make the hill level with the top of the ground." From 10 to 12 seed are scattered throughout the hill and covered 1 to 1½ inches deep. Cultivation consists in thorough shallow tillage, with a loosening of the soil about the plants wherever it becomes compact. After the plants have become thoroughly established and danger from insects is past they are thinned out to about 3 of the most vigorous in each hill.

The more modern method of watermelon culture is to plow out the rows one way; fill the trenches with manure, thoroughly mix the manure with the soil in the trenches by running back and forth with a scooter plow; then throw the soil back again and plant the seed on the bed thus formed. This is a more economical way of preparing the ground on a large scale than by the old method of individual hill preparation. The hills may be planted 10 feet apart each way or the rows made wider apart and the seed planted closer together in the row.

Fig. 214—EARLY FLAT DUTCH TURNIP

Where stable manure is not available for watermelon growing the Georgia Station recommends the following mixture of commercial fertilizers: Nitrate of soda, 400 pounds; high grade acid phosphate, 800 pounds; muriate or sulphate of potash, 200 pounds. This should be mixed and applied at the rate of 700 pounds and upward per acre. For later melons a mixture of 800 pounds cottonseed meal, 800 pounds high grade acid phosphate and 800 pounds of kainit per acre may be used.

No special directions can be given for recognizing with certainty when watermelons are ripe. Some of the indications are as follows: A dead sound when thumped with the finger; a yellowish appearance underneath; the drying up of the tendril or curl opposite the place where the melon is attached to the vine, and finally, if the melon yields somewhat, emitting a kind of crackling sound when firmly pressed downward with the palm of the hand, it is almost certainly ripe.

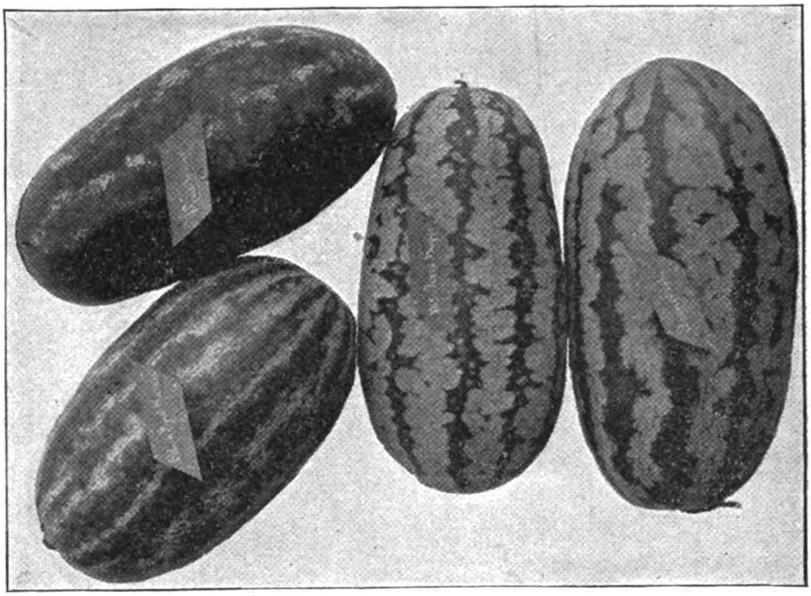


Fig. 215—WATERMELONS
(N. H. Expt. Sta.)

Varieties—Melons weighing between 12 and 25 pounds are considered most desirable. For shipping purposes the Georgia Station recommends Lord Bacon, Kolb Gem, Rattlesnake and Jones Jumbo. (Fig. 215.) Some of the best varieties for culture in the North are Cole Early, a medium sized oval, striped variety; Peerless, an early productive variety with white seeds; Kleckley Sweet, a long, dark green melon of excellent quality, white seeds. Other good varieties are Boss Black Spanish and Phinney Early.

The citron is a variety of watermelon used for preserving. It is inedible in the raw state.

Stock melons or pie melons are a kind of non-saccharine watermelon sometimes planted in corn fields like pumpkins for stock. The fruits weigh 20 pounds or more. They have been grown to a considerable extent in Kansas and Oklahoma for stock.

For further notes on watermelon culture see Ga. Expt. Sta. Bul. 38 and N. H. Expt. Sta. Bul. 86. The first also contains directions for forcing.

For enemies see under *Cucumber* and *Muskmelon.*

PART III

FRUITS AND NUTS

AN IDAHO APPLE ORCHARD

FARMER'S CYCLOPEDIA OF AGRICULTURE

FRUITS AND NUTS

ALMOND (*Prunus amygdalus*)

The extremely early blossoming habit of this nut tree limits its culture to a very few favored localities. Practically all the almonds in this country are grown in California, though the belt of successful nut culture includes also portions of Arizona, Utah, Nevada, New Mexico and Southwestern Texas. The tree itself is nearly as hardy as the peach, and while it blossoms abundantly and is often grown as an ornamental, it seldom bears fruits in Eastern United States. It succeeds best on rich, well-drained sandy or gravelly loams, in hill locations or on high bench lands. While the tree will withstand drouth perhaps better than any other cultivated fruit, profitable crops of nuts are secured only where the rainfall is sufficient or where water for irrigation is available.

The almond is propagated by budding on seedling bitter almond stock. Shield budding, as with the peach, is most practiced. Trees should be set at least 24 feet apart each way and the orchard given shallow and thorough cultivation. Cutting back trees at transplanting time to 1 foot from the ground and forming the head of 3 main branches at this point has been found a very satisfactory practice.

In pruning, almonds should not be shortened in, as with the peach and apricot, since most of the fruit is borne on the slender outer branches and short

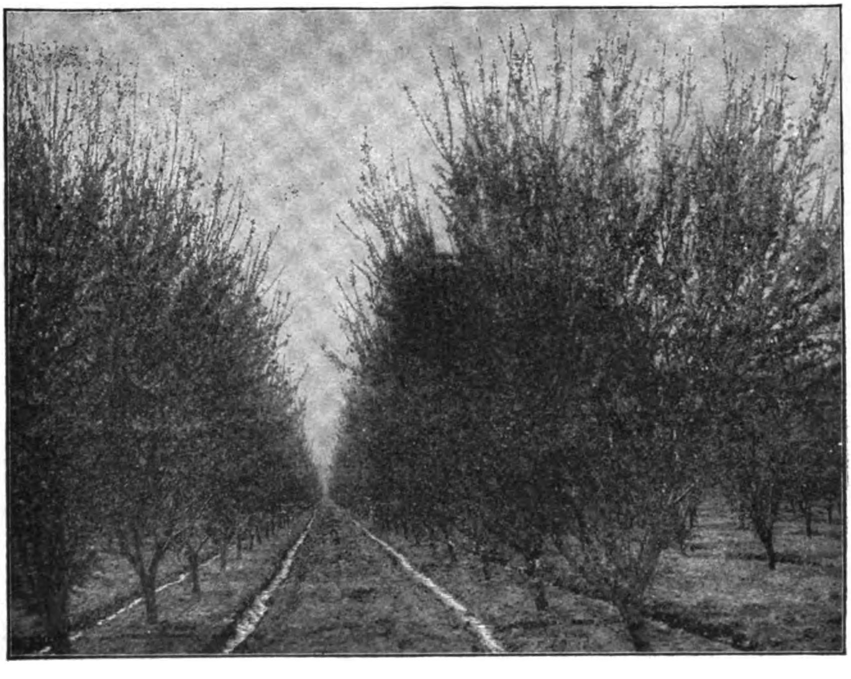


Fig. 217—ALMOND ORCHARD IN ARIZONA
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 105)

fruit spurs on the inside of the trees. The tree is shaped during the first 3 years, after which only dead and crossed branches will need to be removed. Summer pruning should be avoided. An almond orchard in Arizona treated in this manner is shown in Fig. 217.

The trees bear in from 2 to 4 years from budding, but full crops are not secured under 7 or 8 years. The most popular varieties at the present time are I X L, Nonpareil, Ne Plus Ultra, Drake, Paper-shell and Languedoc. About ¾ of the acreage in California is planted to the first 2 varieties named. Trees should be mixed in orchards to insure fertilization of the fruit.

Methods of bleaching almonds, to take the place of the objectionable practice of sulphuring, have been investigated by the California Station. Very satisfactory results were obtained by the following method: The nuts were placed in a cane or splint basket and dipped for about 5 minutes into a solution containing, to every 50 gallons of water, 6 pounds of bleaching powder and 12 pounds of salsoda. "They are then rinsed with a hose, and, after draining, again dipped into another solution containing 1 per cent of sulphate of lime. After the nuts have assumed the desired tint they are again rinsed with water and then dried. Instead of the second dipping, the nuts may be sulphured for 10 or 15 minutes. The cost of 50 gallons of the chlorin dip will be about 40 cents; the same bulk of the bisulphite dip, probably considerably less; the time occupied in handling 1 batch (2 dips), 12 to 15 minutes."

Enemies: Leaf Blight (*Cercospora circumcissa*) is especially injurious in California. The disease attacks the leaves and small twigs, causing the leaves to fall prematurely. The leaves become infected from spores, which pass the winter on twigs of the previous season's growth. The leaves on the outer branches are first attacked and the disease gradually spreads toward the center of the tree. Discolored spots appear on the leaves, and later the affected tissue dies and falls out, leaving small holes in the leaves. The twigs are similarly attacked and pits are formed in the bark. For combating the disease the trees may be sprayed with ammoniacal solution of copper carbonate (see under *Spraying*), before blooming, when the trees are in full leaf, and again about a month later.

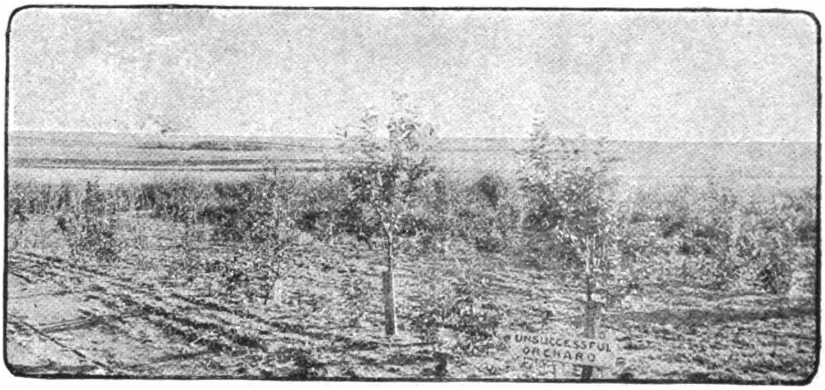


Fig. 218—APPLE ORCHARD WITHOUT WINDBREAK PROTECTION
(From Minn. Expt. Sta. Bul. 72)

The almond is not infested with any special insect pest not common to other fruit trees. It is often attacked by tree hoppers, locusts and scale insects, especially San Jose scale. For other insect enemies see under related trees.

APPLE (*Pyrus malus*)

The smaller but highest colored and firmest apples, and apples of the best keeping quality, are grown in the New England and Northern States and Canada. Farther south the size increases and duller colors prevail. The fruit ripens earlier. The most prominent apple sections in the United States, at the present time, are the New England and Middle States, portions of the mountainous regions of Maryland, Virginia, West Virginia and North Carolina, and

New York, Michigan, Missouri, Arkansas and a large section of the Northwest, including Washington and Oregon. In some of the Gulf States and Southern California the apple is only partially successful. The region from Northern Iowa and Nebraska northward possesses so austere a winter climate that only the hardier sorts succeed. Experimental investigations at the South Dakota Experiment Station show that in test winters only apples grafted on Siberian crab stocks (*Pyrus baccata*) are entirely free from root-killing. Hibernal and Recumbent proved the hardiest varieties of common apples grown. The dwarfing tendency of Siberian crab when used as a stock limits its commercial use to sections where root-killing is a source of constant trouble and to the rich soils of the Northwest, where the trees tend to form wood instead of bearing fruit. As an aid to the protection of nursery stock, the station strongly advises watering trees in the fall before the ground freezes, and then applying a heavy mulch. The Montana Station recommends Transcendent and Virginia crabs as apple stocks for that State. Trees are protected at the station from excessive cold in winter by wrapping the stems, from the ground to the crotches, with newspapers. The beneficent effects of windbreaks are seen in Figs. 218 and 219.

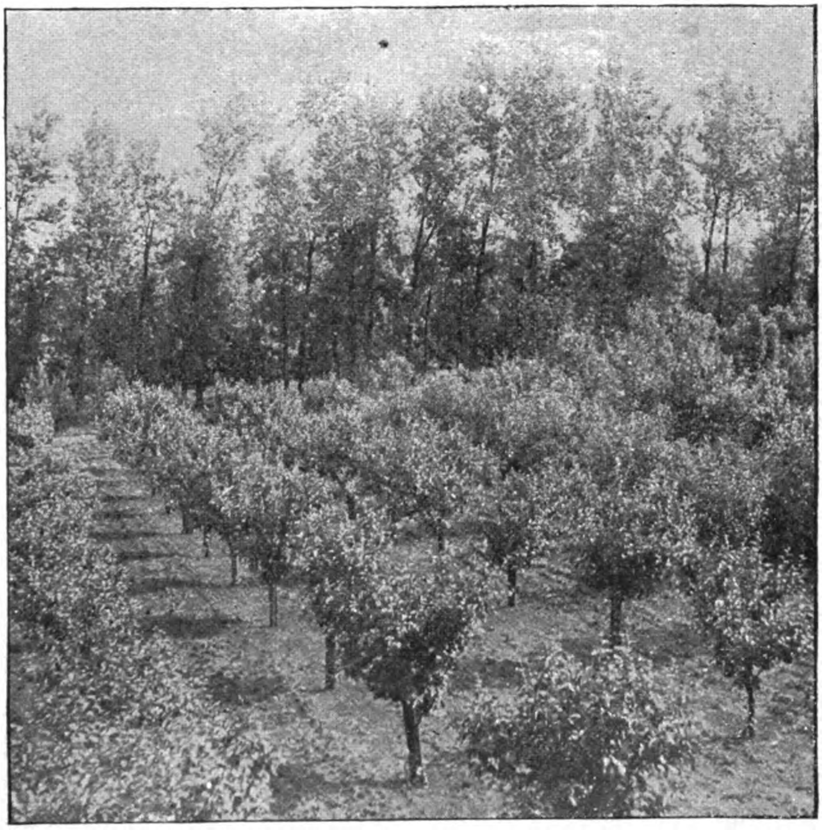


Fig. 219—APPLE ORCHARD WITH WINDBREAK PROTECTION
(From Minn. Expt. Sta. Bul. 72)

For the technique of budding and grafting apples see *Grafting.*

Root-Grafting—Experiments at the Kansas Station with various lengths of cions and different portions of roots for grafting showed that the difference of growth in favor of the longer cions and stocks is probably not sufficient to compensate for the extra labor and expense made necessary by their use. Cions about 6 inches long grafted on piece roots 3 to 5 inches long will make as good trees as longer cions grafted on whole roots.

It was also shown that where the graft is buried deeply in the soil, a new system of side shoots will take the lead at about the usual depth below the surface of the soil, to the more or less complete dwarfing of the lower and earlier root system. At the Alabama College Experiment Station and also at the Illinois Station work in root-grafting indicated that whole root-grafted apple trees are of no greater value to the buyer than trees grafted on medium-sized piece roots.

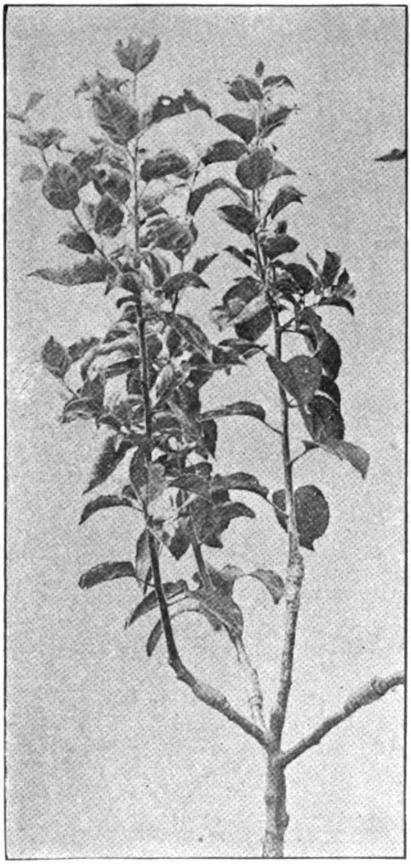


Fig. 220—TOP-GRAFTED STAYMEN TREE THREE MONTHS AFTER GRAFTING
(From Powell, Del. Expt. Sta. Bul. 48)

Root vs. Top-Grafting—The relative effects of top-grafting and root-grafting on the longevity of some varieties of apples have been studied by the West Virginia Station. With the King variety all the root-grafted trees were dead at the end of 10 years, while the top-worked trees were in a fairly good condition 20 years after being worked. With the Walldow variety all of the top-grafted trees were living and in a thrifty condition at the end of 20 years, while the root-grafted specimens were all dead, except 1 branch of 1 tree. Tallman Sweet is recommended by the station for double-working trees. *i. e.*, seedlings root-grafted with Tallman Sweet and then top-worked with the variety which it is wished to propagate.

In summing up the evidence and best practices of apple growers in Delaware, Prof. Powell states that a few apple growers are planting a hardy, vigorous, straight growing variety as a stock on which to tôp-work a permanent orchard. It is claimed for this method that it provides a healthy, strong trunk for all varieties, corrects the poor growth of some, overcomes the tenderness of others in the far North, and sometimes makes a stronger system of roots. This method also gives the grower a chance to select the buds or cions from trees of steady productiveness, hardy foliage and highly colored fruit—factors of the greatest importance in commercial orchards. It is also said to hasten fruitfulness. The Spy is believed to make an ideal stock for top-working, and the Ben Davis, Baldwin, Lily of Kent, Tallman Sweet and Astrakhan are also good. Seedling stocks are considered undesirable for top-working, as no two of them are alike. A top-grafted Staymen tree is shown in Fig. 220.

The trees should be budded the second summer after planting, or grafted the following spring. June budding is also practiced, and sometimes all of these methods are advantageously combined on a single tree. Body budding seems to be the most desirable method. Considerable attention must be given the top-worked trees the first season in shaping and heading back the cions. This method permits of the top-working of large, vigorous apple trees of undesirable sorts with better kinds. Only a portion of the tree should be top-worked each year.

Location and Soil—The ideal location for an apple orchard is on a gentle eastern or northeastern slope which enjoys both air and water drainage. These latter are essential factors in the commercial success of the apple orchard. Modern experience has shown that no soil is too good for the apple. Sandy lands and low, flat meadow locations should be avoided. Newly cleared timber lands, limestone soils and loamy clays are especially desirable for apples, and in a suitable climate insure satisfactory results. Apples in quantity sufficient for home use can be grown practically anywhere in the United States where ordinary farming can be carried on. The apple orchard should be deeply plowed and thoroughly cultivated before the trees are planted therein.

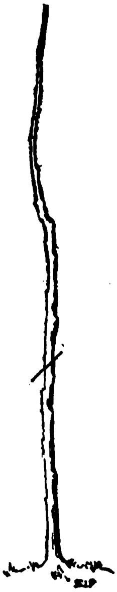


Fig. 221—ONE-YEAR-OLD TREE WITH LINE TO SHOW WHERE TO CUT BACK (U. S. Dept. Agr.)

Planting the Trees—One or 2-year-old trees are better for setting out than older stock. Spring planting, on the whole, is safer than fall planting and is quite generally recommended for the whole country. The trees should stand from 32 to 40 feet apart each way in the orchard. The greater distance is recommended for the most vigorous growing varieties. When 1-year-old trees are planted the top should be cut back to the point where the future head is to be formed, as shown in Fig. 221, the roots shortened somewhat, and all bruised and broken ones removed. If 2-year trees are planted the leader and branches should be cut back one-third to one-half, as shown in Fig. 222. In planting, the roots should be placed in a natural position and fine soil filled in among them, tramping it firmly down with the feet. It is advisable to set the trees a little deeper than when in the nursery and have them lean slightly to the south or southwest, to brace them against prevailing winds. In some of the Southern and Atlantic coast States cutting all the roots back to stubs not more than 3 to 8 inches long has given very satisfactory results. Experiments at the Delaware Station indicate that pruning the roots to a length of 3 to 5 inches will give most satisfactory results in that State. In some of the Northern and Western States where light rainfall prevails close root pruning at the time of setting has not proved as satisfactory as the ordinary methods of planting.

Cultivation and Cover Crops—Starting from the first year after setting out, the orchard should be plowed deeply every spring. This sends the roots downward, where they are needed in time of drouth. Fall plowing, though sometimes practiced to induce earliness, is not generally advisable. For the first 4 or 5 years, cultivated crops, like potatoes, corn or small fruits, may be grown between the rows. They should not be grown so close to the trees, however, as to shade them or to prevent cultivation of the trees for several feet on every side. Grain crops or grass should never be permitted in the orchard at any time, except under special conditions, where it is desired to throw an overluxuriant orchard into bearing, or where the ground is badly drained and the excess water can be best evaporated by a growing crop. On steep hillsides

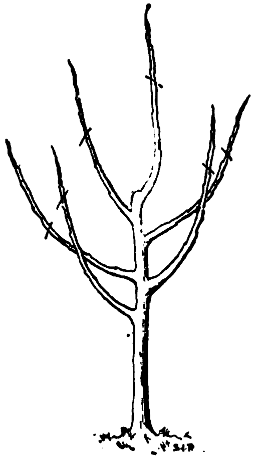


Fig. 222—TWO-YEAR-OLD TREE WITH LINES TO SHOW WHERE TO CUT BACK AT TRANSPLANTING (U. S. Dept. Agr.)

also where cultivation is impracticable clover or alfalfa may be seeded. Where orchards are kept in grass the grass should be mowed and left to lie in place under the trees to rot. Sometimes very good results are secured in orchards treated by the latter method but generally clean cultivation until midsummer each year followed by some cover crop will give the best results.

The primary objects of orchard tillage are to make more available the plant foods of the soil and to conserve the soil moisture to the use of the trees. Experiments in Missouri show that trees that are well cultivated make a more uniform and vigorous growth, are healthier, produce better fruit and are less unfavorably affected by drouth than those not cultivated. The value of cultivation in preserving soil moisture is well brought out in some experiments by the New York Cornell Station. In a well-tilled orchard the moisture content of the soil to the depth of 1 foot, on September 1, varied from 11.3 to 12.8 per cent, while in an adjoining untilled portion it varied from 8.7 to 9.6 per cent. In the tilled soil the moisture was within 2 inches or less of the surface, while in the untilled the first few inches—which is the richest portion of the soil—was exceedingly dry and was therefore inactive.

Orchards given clean cultivation at the Kansas Experiment Station one season contained 16 per cent of moisture when the orchard in grass contained but 6 per cent. At the Nebraska Station a cultivated orchard contained 20 per cent of moisture when an orchard in grass contained but 14 per cent. Generally speaking the most serious injuries to orchards occur when crops are planted in them that sap the soil moisture early in the season like grasses and the cereal grains. Potatoes, beans and like vegetables that cannot be planted until later in the spring are distinctly less injurious. When orchards are in full bearing no crop for profit should be grown in them at all.

At the present time practical horticulturists recommend, and station experiments confirm, the practice of thorough tillage of the orchard until July or August, then seeding the orchard down to some nitrogenous cover crop. like red or mammoth clover, vetch, cowpeas, alfalfa, or crimson clover. Rye is a favorite cover crop on lighter soils. In wet years cultivation should cease earlier in the season in order to give the trees plenty of time to mature their wood growth before winter sets in. These cover crops, when plowed under the following spring, add humus to the soil, improve its mechanical condition and increase its capacity to hold soil moisture. They also protect the ground over winter from alternate freezing and thawing and from freezing so deeply. In the cold, dry Northwest the orchard should not be sown to cover crops, but kept cultivated till late fall in order to preserve the soil moisture for the trees over winter. Orchard cultivation as practiced in Illinois is shown in Fig. 223. In addition to the crops mentioned above, oats, Canada field peas and oats, buckwheat, cowhorn turnips, etc., have been found very satisfactory cover crops for orchards. Soy beans are not so valuable. The vines do not mat down upon the approach of winter and protect the ground from freezing nor do they hold the snow very well. When red, mammoth or crimson clover is used 15 to 20 pounds per acre should be sown; alfalfa, 30 pounds; hairy vetch, 40 to 50 pounds; rye, 1 to 1½ bushels; cowpeas, 90 pounds; oats, 2 to 2½ bushels; buckwheat, ½ to ¾ bushel.

Manuring—In the fertilization of orchards potash is generally the most important element to be applied, particularly after the trees have reached bearing age. On the farm this can be best supplied in the form of unleached wood ashes, from 40 to 50 bushels per acre being applied to bearing trees each season. The ashes also supply a certain amount of phosphoric acid and lime, which are necessary in fruit and wood production. Where good wood ashes are not obtainable, from 500 to 700 pounds per acre of muriate of potash may be used in mature orchards. Next to potash in importance in most orchards is nitrogen, and this can be best supplied in well-rotted barnyard manure. Nitrogen is especially valuable in promoting wood growth and in rejuvenating old, worn-out orchards. It can be safely and advantageously used in all old farm orchards. It is generally thought that when mature or bearing trees do not make a foot or more of growth upon all shoots, or when the tree matures early in the season and the leaves have a yellowish appearance, that nitrogen is needed. If, however, the trees make a strong, vigorous growth each season, and the leaves are of good size and dark color, the free use of nitrogenous manures is likely to be more harmful than beneficial. In such cases the legumes should not be used as cover crops. In commercial orchards the cheapest method of supplying nitrogen to the orchard is by cultivation and the use of nitrogenous cover crops each season, as noted above. "If the orchard is not growing and is yellowish in foliage, good cultivation—begun early and repeated very frequently—in connection with the use of potash, phosphoric acid and green manures, will probably correct it." (L. H. Bailey, N.Y. Cornell Expt. Sta. Bul. 72.) Trees which fail to respond to this method of treatment may sometimes be brought into a vigorous condition by an application of a light dressing of nitrate of soda (150 pounds per acre), but this treatment need seldom be applied to an entire orchard. It is a waste of time and money, however, to use commercial fertilizers without accompanying them with thorough tillage. Recent experiments would seem to indicate that phosphoric acid is the most essential element in the production of highly colored apples. Where it is needed an application of 150 to 200 pounds of acid phosphate per acre will usually be found abundant.

Pruning—Apple trees are pruned primarily for the purpose of forming a symmetrical, evenly balanced head, and for the admittance of sunlight and the free circulation of air. All dead limbs, and limbs that rub against each other, should be removed, care being taken not to leave the limbs and trunks exposed to the direct intense heat of the sun's rays, which frequently causes the disease known as sunscald. The value of light in the production of fruit buds was studied at the Rhode Island Station, and it was found that there was a much larger number of clusters of fruit buds upon limbs that grew in sunlight than upon similar limbs from the same trees that grew in shade. This would seem to indicate the value of so pruning that light may be admitted equally to all portions of the tree. In the Central and Eastern States the head should be formed 2 or 3 feet from the ground and trained to a round, open form. Pruning can be best done in late winter or early spring. Besides thinning out the dense growths and crossed branches, all side branches that are making too strong a growth should be checked by heading in. Most of the pruning and formation of the tree should be done while it is young. Trees pruned to a vase or goblet form, by cut-

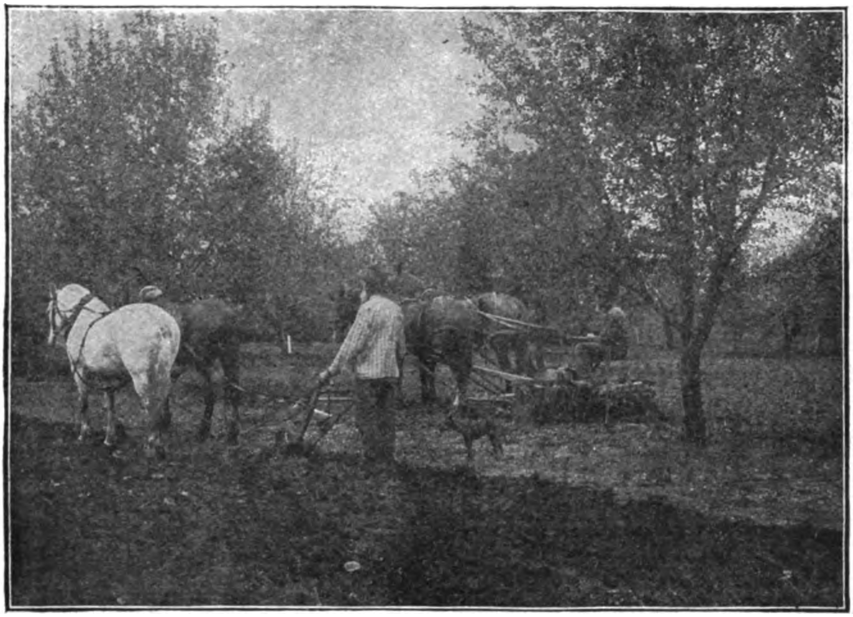


Fig. 223—ORCHARD CULTIVATION AT THE ILLINOIS STATION
(From True & Clark, U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

ting out the central stock or leader, have been found most desirable in California.

Harvesting and Storage — Apples should be harvested as soon as they have attained their maximum size and weight and while they are still firm. If gathered at this time they develop a finer flavor and keep much better in storage than if permitted to ripen on the tree. The storage room for apples should be free from air currents and the temperature should be maintained as near freezing point (32° F.) as possible. It is better to store them in boxes or drawers than on open shelves. Bruised fruit should not be stored. It does not keep well and spreads decay to the sound fruit. The apples should be picked from the trees by hand. The quicker they are placed in cold storage after picking, the better they will keep. They will keep fresh, juicy and sound a month to 6 weeks or 2 months longer if wrapped. Wrapping each fruit first in unprinted newspaper and then in waxed paper has been found as satisfactory a method of wrapping as any. Even once wrapping with common newspaper will considerably prolong their keeping quality.

Utilization of Waste Apples—Apples which are of too poor a grade to be marketed can be profitably used for evaporating, or making into jelly, marmalade, cider and vinegar. With a hand grinder and press but little more than 2 gallons of cider can be obtained from a bushel of apples. By the use of a medium sized horse power grinder and press 4 gallons of cider can be easily obtained from a bushel of apples. Good cider jelly can be made by adding about 1 pound of sugar to each 5 pounds of cider. This will make 40 pounds of jelly for each 100 pounds of cider. For apple marmalade a better quality of apples is required than for cider. A good quality of marmalade can be made by the use of 10 pounds of sliced fruit to each 4½ pounds of sugar and cooked down with 1 gallon of cider. With apples at 20 cents per bushel marmalade can be made for about 2 cents per pound. If the apples are cored and pared before using the waste will be about 25 per cent; if cooked and run through a colander the waste will hardly exceed 5 per cent.

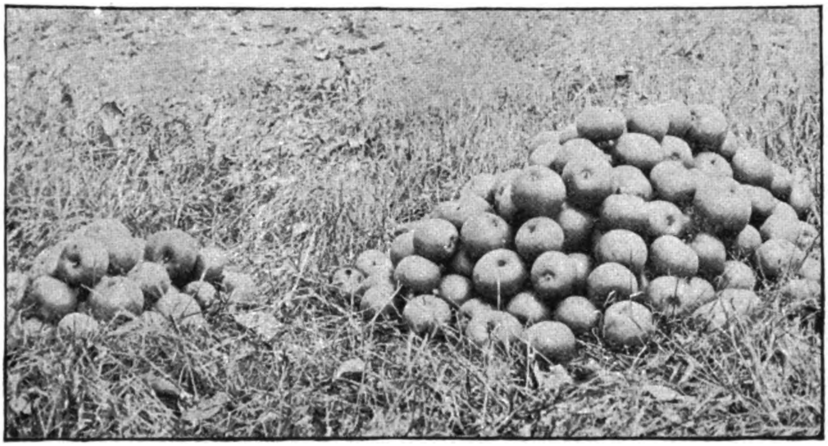
In evaporating apples a bushel of fruit will make on the average 6 to 7 pounds of dried product. A better quality of evaporated product will be secured if apples are used that are still firm and somewhat green rather than apples ripe enough for dessert. Some of the best varieties for evaporating are Patten Greening, Baxter, Ben Davis, Golden Russet, Northern Spy, King, Ribston Pippin, Twenty Ounce and Pewaukee. The Patten Greening is reported by the Canada Central Farms Station to have yielded 16 pounds of evaporated apples per bushel of fruit.

In making vinegar from fresh cider on the farm, the cider should be put in clean barrels and allowed to ferment. Under ordinary conditions it requires 3 to 7 weeks for the sugar in sweet cider to become completely converted into alcohol or before it becomes "hard cider." Under the influence of an acetic acid ferment hard cider is gradually converted into vinegar. This process is hastened if the depth of the liquid in the barrel does not exceed its surface measurement. Air should be admitted freely at all times and the barrel kept in a uniformly warm temperature. Sweet cider should never be added to old vinegar, as is often done on the farm, since the presence of the acetic acid in the vinegar prevents the conversion of the sugar in the cider into alcohol and only a poor watery vinegar will be obtained. After sweet cider has completely fermented then the addition of a small quantity of mother of vinegar to it will hasten its conversion into vinegar. It requires 6 months to a year for hard cider to become completely converted into vinegar when kept in an ordinary warm cellar and air freely admitted to it. For a further account of cider and vinegar making see Va. Expt. Sta. Buls. 48, 57, 127, 137, 138, 139; U. S. Dept. Agr. Bureau of Chemistry Bul. 71; Ore. Expt. Sta. Bul. 73; "Effects of Fermentation upon the Composition of Cider and Vinegar," by C. R. Browne, Jr. (Jour. Am. Chem. Soc. 25 (1903), No. 1.)

Varieties—Relative to varieties of apples not much can be said. Over 4000 varieties have been in cultivation, but less than 200 are grown commercially, and the same variety varies greatly in the different sections of the country in quality, form and value for commercial purposes. The best guide in the selection of varieties is to see what varieties are most successful in surrounding orchards. Advice on the matter can usually be obtained by consulting the State Experiment Station, and further information can be obtained by consulting the carefully prepared list of fruits for the different sections of the country, as revised by the American Pomological Society and the Division of Pomology, and published by the United States Department of Agriculture from time to time. The United States Department of Agriculture has also published a Farmers' Bulletin on "The Apple and How to Grow It," which contains a list of the most suitable varieties for the different sections of the country, and this may be obtained free upon application to the department. In general, the more prominent commercial varieties are Oldenburg, Maiden Blush, Red Astrakhan, Northern Spy, Baldwin, Ben Davis, Rhode Island Greening, York Imperial, Jonathan, Gravenstein, Winesap, Hoover, Benoni, Wealthy, Fameuse and Yellow Bellflower.

Dwarf apples find little cultivation in the United States. They are obtained by grafting our common cultivated apples on Paradise apple stock. A discussion of their commercial value may be found in N. Y. Cornell Expt. Sta. Bul. 116.

General Scheme for Spraying Apple Trees—Apple scab and codling moth are the 2 worst enemies of apples in the Eastern and Middle States. These and most other serious apple troubles may be effectively controlled by 4 applications of a combined Bordeaux mixture and Paris green solution as described under *Spraying*. The first application should be made just before the flower buds open, the second just after the petals fall and the third and fourth at intervals of 10 days to 2 weeks. The fourth may sometimes be omitted. In the following paragraphs directions are given for treating the more important apple enemies. The effect of spraying on apple trees is shown in Fig. 224.



Unsprayed Sprayed

Fig. 224—EFFECT OF SPRAYING
(From Card, R. I. Expt. Sta. Bul. 83)

Enemies: BITTER ROT (*Gloeosporium fructigenum*) is perhaps most common on certain sweet varieties of apples. The fungus appears later than the apple scab. The disease is often associated with brown rot, and is not to be distinguished for practical purposes from black rot. The disease attacks any part of the apple and spreads rapidly. Bitter rot is to be recognized by the presence of numerous black pustules just under the skin of the apple in the older infected areas. The fungus penetrates into the substance of the apple and causes a softening of the tissues and a change of color to brown. The fungus passes the winter in decayed fruit and may be transmitted to sound fruit in barrels and bins. Infected apples should not be packed with sound fruit. Trees should be sprayed with ammoniacal copper carbonate when bitter rot first appears, and again 2 weeks later.

RUST (*Gymnosporangium macropus*) is a disease due to a fungus which spends a part of its life cycle on the cedar, where it is the cause of the "cedar apples." In the early spring the cedar apples appear and spores are carried from these structures to apple and other related trees. Leaves infected with these spores develop orange spots on the under surface, and later cup-shaped bodies on the under side. In these cups spores are formed, which are blown away by the wind and reinfect cedar trees. The fruit of the apple is usually attacked about the same time with the leaves. In bad cases the leaves turn yellow and fall off. By destroying cedar trees in the vicinity of orchards the spread of the disease may be checked. Where this is impossible, the cedar apples may be gathered and destroyed and apple trees sprayed with Bordeaux mixture.

SCAB (*Fusicladium dendriticum*) attacks the fruit and leaves of apple and pear trees. On the leaves the disease is often called leaf blight. Black spots of considerable size are formed on the fruit. As the spots increase in size the diseased tissue cracks open, growth ceases, and the fruit becomes one-sided. The spots on the leaves are similar to those on the fruit, except that the edges are not white. The leaves are made to curl somewhat by the development of the disease. Scab is the most important fungous disease of apples, but the amount of injury varies greatly from year to year. For combating scab spray with Bordeaux mixture when the buds are swelling, again just before blossoming, and a third time after the flowers have fallen.

CROWN GALL is a disease in which enlargements occur near the ground on nursery stock. It has been found on apple, peach, apricot, prune, plum and other trees, as well as on raspberry and blackberry. In Arizona the fungous cause of the disease has been determined as *Dendrophagus globosus*. Crown gall is largely spread from infested stumps. Dead trees are often dug up and allowed to remain near the orchard. The disease is thus spread from such material. Nursery stock showing large swellings at the crown should not be accepted or planted. In some cases a cure may be effected by cutting off the galls and painting the cut surface with a paste made of bluestone and lime. It is perhaps better to destroy all diseased stock. Crown gall sometimes closely resembles the swellings produced by woolly aphis, but the work of the latter may usually be recognized by the presence of the insect.

POWDERY MILDEW (*Podosphaera oxycanthae*) attacks the leaves of apple seedlings in spring and checks their growth during summer. The leaves become covered with a powdery substance and shrivel up. The disease may be controlled by spraying with ammoniacal solution of copper carbonate when the leaves first unfold and 4 or 5 times afterward at intervals of 10 days.

SOOTY FUNGUS (*Leptothyrium pomi*) is most injurious to apples grown in moist localities. Affected apples show black, irregular blotches and numerous small spots on the skin. The disease is supposed by some to be transmitted to sound apples after storing. In preventing the attack of sooty fungus orchards should be planted in high, sunny situations, and trees should be sprayed with Bordeaux mixture when the apples are about ½ inch in diameter.

SUNSCALD is a term applied to a dying of the bark and growing tissues on one side of a branch or trunk. The trouble usually appears on the southwest side of trees in winter. In different localities different fungi are associated with the disease. The injuries are in part due to winter freezing, by which the bark is ruptured and the entrance of the fungi rendered easy. For preventing the trouble apple trees should be headed low and the trunks should be protected against the action of the sun by wrapping paper or other substance loosely around the trunk, as seen in Fig. 225, or by setting up 2 boards nailed together on the southwest side of trees in winter.

CANKER (*Nectria ditissima*) (Fig. 226) attacks the apple, beech, oak and other shade trees. It has only recently been recognized in this country. The fungus gains entrance to the tree through wounds in the bark. As the disease progresses the bark cracks, often in such a manner as to girdle small branches. Later the wood is attacked. Usually a swollen ridge of bark is produced around the edge of the canker wound. Trees which have been destroyed by canker and badly affected branches should be cut and burned.

TWIG BLIGHT—See *Pear Blight.*

BROWN ROT—See under *Peach.*

ROOT ROT (*Clitocybe parasitica*) attacks apple, peach, oak and other trees. The fully developed fungus is a mushroom of honey color, becoming yellow or brown with age. The mushroom appears about the base of badly infested trees. The first symptom of the disease is an excessive exudation of gum at the crown of the tree. Ditches may be dug around affected trees so as to prevent the spread of the fungus through the soil. Orchards should not be planted on ground occupied by oak stumps. Badly diseased trees should be burned. Care should be exercised not to injure the roots of trees by cultivation, since the disease may gain entrance through such injuries.

Besides the diseases already mentioned the apple is subject to 2 or 3 forms of canker, "hairy root," king disease, fruit rot, core rot, leaf spot, fruit spot, etc. These diseases, however, seldom attain economic importance.

Codling Moth (*Carpocapsa pomonella*) is about ½ inch across the wings. The forewings are gray, crossed by brown lines. The moth usually flies at twilight or night. The eggs are laid on the surface of the apple, in the calyx, or on the leaves. After hatching, the caterpillar eats its way into the apple, either at the calyx end or on the side. Within the apple it grows to a length of ¾ of an inch, burrowing around the core and finally eating a hole to the outside. There are 2 broods annually, and perhaps a third brood in some States. The caterpillars of the second brood winter over in the apple. The insect infests also pears and sometimes peaches and plums.

In general, good results are obtained by spraying the trees with Paris green, in the proportion of 1 pound to 200 gallons of water, a week after the blossoms fall. The first application should be made before the calyx closes. A second application of Paris green should be made at the time the eggs are being laid on the twigs or fruit for the second generation. Another remedy which may be applied at the same time with spraying consists in scraping the bark smoothly around the tree and placing paper or cloth bands in this position. These bands may be examined frequently and the caterpillars found under them may be destroyed. The effectiveness of these methods varies in different localities. In some experiments about 75 per cent of the first brood of worms were killed by a spray of Paris green, while in other experiments the banding method was found to be exceedingly effective. Some observations indicate that no special advantage is derived from keeping hogs in the orchard for the purpose of eating windfalls, since the majority of caterpillars were found to have left such apples. (Neb. Expt. Sta. Bul. 51; Ida. Expt. Sta. Bul. 21; N. Y. Cornell Expt. Sta. Bul. 142.)

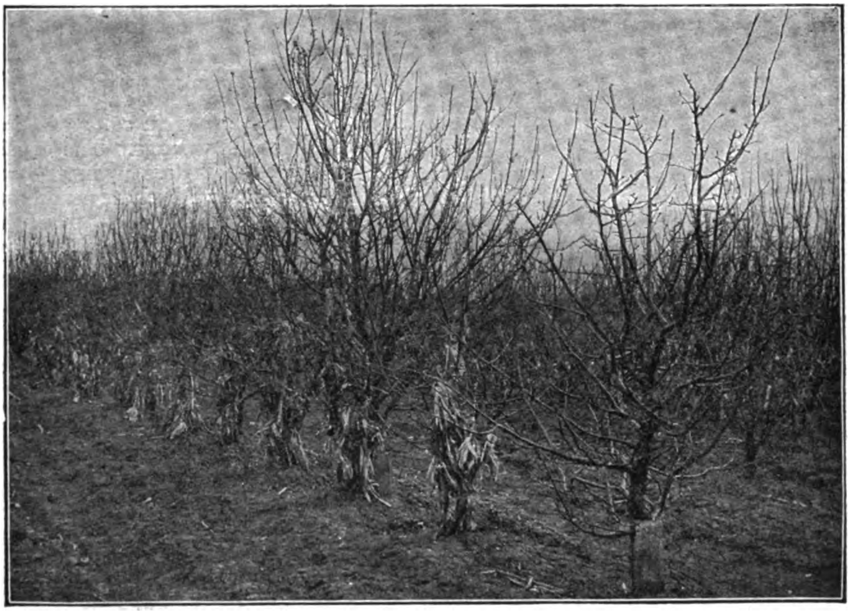


Fig. 225—PROTECTING TREES AGAINST SUNSCALD
(True and Clark, U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

Apple Curculio (*Anthonomus quadrigibbus*) is a beetle smaller than the plum curculio and of a dark brown color. It has 4 brownish humps upon the hinder portion of the body. This insect drills holes into young apples by means of its snout for purposes of feeding and also for places in which to deposit eggs. As soon as the grub hatches it burrows into the core, where it feeds. Apples infested with this insect usually do not fall to the ground, and the species is, therefore, difficult to combat. Picking affected apples from the tree and jarring the curculio into traps, as recommended for the plum curculio, are effective against this insect.

Apple Maggot (*Trypeta pomonella*) is a fly smaller than the common housefly and may be recognized by its black color, yellowish head and legs and the presence of white bands across the abdomen. The flies appear early in June and bore holes in the apples, in which they lay their eggs. The eggs hatch within a few days and the maggots feed on the pulp of the fruit, which they honeycomb completely. When the maggots become full grown they leave the apple and burrow into the ground, where they undergo their transformation, occasionally, however, remaining in the apples. Spraying with insecticides gives unsatisfactory results. The collection and destruction of windfalls and refuse under the trees and from bins and barrels in which fruit has been stored are more effective means of repression.

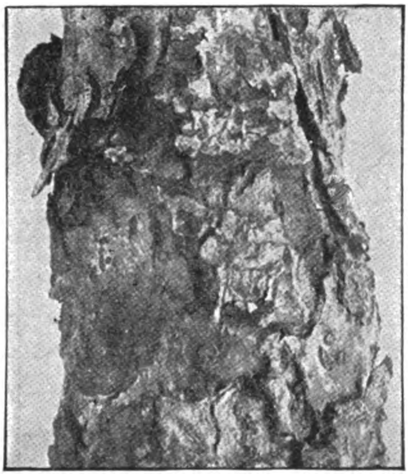


Fig. 226—APPLE CANKER
(N. Y. State Bul. 185)

Borers—Two species are especially injurious to apple trees and are known as the flat-headed and round-headed apple tree borers. The round-headed borer (*Saperda candida*) is a beetle about ¾ of an inch in length, of a brown color, with 2 white stripes on the back. The eggs are deposited on the bark near the ground, and on hatching the grub enters the wood. The flat-headed borer (*Chrysobothris femorata*) is smaller, of a dull color, with a metallic luster. This beetle lays its eggs on the trunk or larger branches, and the grub enters the sapwood. The grub remains in the wood 2 years, while that of the round-headed borer lives 3 years in that position. Both species may do great damage, especially to young trees. Painting the trunks with whale-oil soap or dilute soft soap in the spring and digging out the grubs in the fall are recommended. Good results have also been obtained by covering the trunk with a poisoned whitewash.

Tent Caterpillar (*Clisiocampa Americana*) is the larva of a night-flying moth which is brown in color and about an inch across the wings. The eggs are laid in July in clusters upon the small twigs of apple, wild cherry and other trees. They hatch in the early spring and the young caterpillars form a tent, in which the whole colony lives. They usually feed twice a day, about the middle of the forenoon and the afternoon, at which times the tents are deserted. Each caterpillar remains in connection with the tent by a fine thread, spun as it crawls. When not feeding they remain in or on the tent. A number of birds feed upon the caterpillars, and a contagious disease prevails at times during moist warm weather. The egg masses may be readily seen and collected, and the caterpillars may be destroyed in their nests by saturating with kerosene and burning. The nests should be burned in the early morning or late in the afternoon, when the caterpillars are in them. Spraying with Paris green or other arsenicals will destroy the caterpillars.

Twig Borer (*Amphicerus bicaudatus*) is a beetle about 1-3 of an inch long, of a brown color, black beneath. It bores into apple twigs in the early spring, entering near the bud and making a burrow several inches in length. The insect also attacks grape, pear and cherry twigs in the same manner. Usually the beetles leave their burrows in summer and deposit their eggs in the roots of the greenbrier or in the dead shoots of grapes. Infested wild grape vines should be removed and apple twigs containing the burrows of the beetle should be cut off and burned.

Apple Tree Bucculatrix (*Bucculatrix pomifoliella*) is a moth about 1-7 of an inch long. The small yellow or green larvae of this species feed on the under surface of the leaves, causing them to turn brown. The cocoons of this insect are white and are readily seen on the lower side of small twigs. They may be sprayed with kerosene or burned. The caterpillars are easily destroyed by spraying with arsenites.

Apple Tree Caterpillars include the yellow-necked (*Datana ministra*) and red-humped (*Oedemasia concinna*). These insects are readily distinguished in the caterpillar stage by the characteristics suggested by their common names. The moths into which they later develop measure an inch or more across the wings. The caterpillars are about 2 inches long when mature. They feed upon the leaves, and as they usually keep close together may be easily removed and burned. The use of arsenicals is effective against these species.

Bud Moth (*Tmetocera ocellana*) is of a gray color, from ½ to ¾ of an inch across the wings. The eggs are deposited in summer and hatch into small caterpillars, which feed on the leaves under a web which they weave, and in which they hibernate on the twig. The caterpillars feed upon the leaves and flower buds of the apple, plum, blackberry and related plants. The bud is destroyed by eating out the center and the growth of the plant is thus checked. Caterpillars feed mostly at night. Bordeaux mixture, to which Paris green is added at the rate of 1 pound to 200 gallons, gives good results in preventing the ravages of this insect. The first spraying should be done when the buds are small, and a second spraying should follow just before the flower buds open.

Canker Worms (*Anisopteryx vernata* and *A. pometaria*)—The chief difference between these species is in the time of egg-laying, the former laying them in the spring, the latter in the fall. In both species the male is of a grayish color, about an inch across the wings, while the female is about ½ inch long and wingless. The caterpillars are commonly called measuring worms, on account of their mode of motion. They feed upon the leaves of apple, pear, peach, other fruit trees and the elm. The trunks of trees may be smeared with a band of tar and printers' ink, mixed with oil, for the purpose of preventing the wingless females from crawling up the trunks to deposit their eggs. Another preventive treatment consists in placing inverted cones in which oil or some similar substance is placed about the trees. The caterpillars may be destroyed by 1 or 2 early sprayings with Paris green or arsenate of lead.

Cicada (*C. septendecim*) (Fig. 227) is also called the 17-year locust, on account of the length of time which it spends in the ground in an immature stage. The insect is wedge-shaped, with a broad head, of a brownish-black color, with red veins in the transparent wings. The 17-year locust is readily distinguished from the common dog-day locust by the fact that the latter is larger and has green veins in the wings, as well as a greenish body, with a white powdery covering on the under side. Some of the Southern broods spend only 13 years in the immature stage, while in the North the life of the insect extends over 17 years. The adult cicada lives about a month and causes considerable damage by depositing its eggs in small twigs of the apple, oak and various other trees. The eggs are laid in a double row in a slit made in the wood, and when the insects are present in large numbers the trees are often killed by this operation. As soon as the young hatch they fall to the ground, and live for the remainder of the 13 or 17 years, according to the brood, in the ground, where they feed upon the roots of trees and herbaceous plants. There are 21 well-known broods of this insect

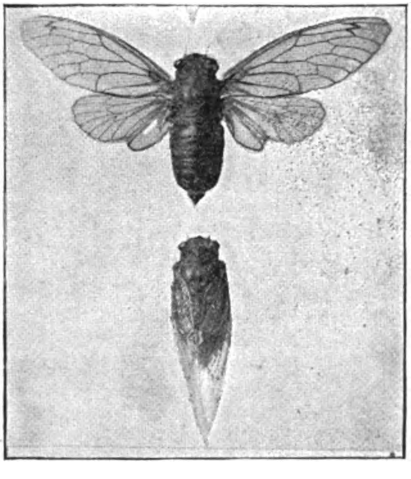


Fig. 227—SEVENTEEN-YEAR LOCUST
(After Felt)

in the United States, but the broods overlap one another, so that locust years are not 13 or 17 years apart. Kerosene emulsion will destroy the cicadas when they first emerge from the ground, but no remedies can be applied after the swarm has begun flying about. Hogs root out and destroy the immature cicadas in the ground, and domestic fowls, sparrows and other birds feed upon them when they appear. Since the time of the appearance of each brood is predicted for a number of years ahead, it is recommended that no pruning be done during the fall preceding the appearance of the swarm. A number of twigs will be destroyed by the cicadas, and these may be cut off in the spring. (U. S. Dept. Agr., Div. of Entomology, n. ser., Bul. 14.)

This list includes the more important injurious insects of the apple tree. More than 200 species of insects have been found depredating upon the apple, but the majority of these are not common or feed chiefly upon other plants. For treatment of the green apple aphis and woolly aphis, an illustration of which is seen in Fig. 228, see *Plant Lice,* under *Cabbage.* For treatment of San Jose scale and other scale insects see these subjects, under *Peach.*

POCKET GOPHERS—These animals are recognized by their stout, compact bodies, small eyes, and strong front feet, which are armed with long curved claws. The front teeth are also very strongly developed. The pocket to which the name of these animals is due has an external opening outside of the mouth. When feeding they rapidly gather materials together, which are stored in the pockets, and then retire to a safe retreat where their food is eaten. A number of species of pocket gophers are found in the United States and their distribution extends from Illinois to the Pacific Coast and includes Georgia and Florida. Pocket gophers spend their life underground and are seldom seen. Rarely they are observed following a road or trail. These animals are especially injurious to potatoes and other root crops, and to fruit trees, of which they gnaw the roots. Bounties have been offered for these animals, but this method of extermination has not been satisfactory. The pocket gophers may be destroyed by fumigation, trapping, bisulphid of carbon, or poison, as recommended for ground squirrels. Another method which has proved very satisfactory in protecting orchards against the inroads of pocket gophers consists in surrounding the orchard with a trench, walled with boards, and dug to a depth of about 3 feet. The gophers in burrowing through the soil fall into the trench and are unable to escape. (Div. of Biological Survey Bul. 5.)

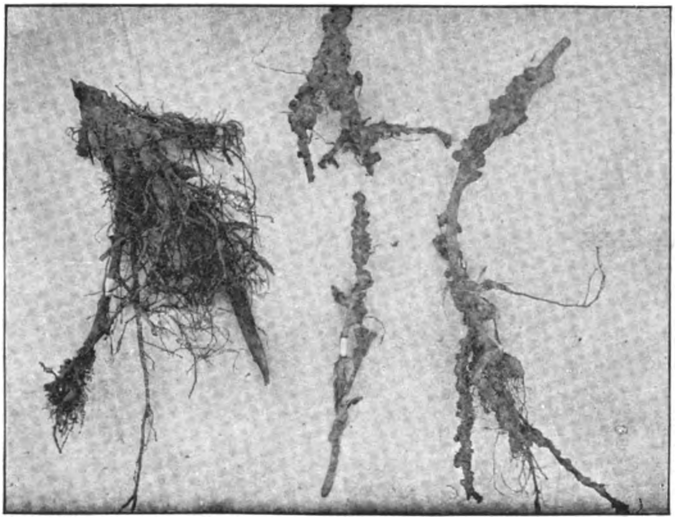


Fig 228—WOOLLY APHIS GALLS ON ROOTS
(Ark. Expt. Sta. Bul. 71)

APRICOT (*Prunus* spp.)

A tree and fruit somewhat intermediate between the peach and the plum, as seen in Fig. 229. The fruit generally ripens in advance of both the peach and the plum, is somewhat peach-like in shape and color, has smoother skin, with rich yellow flesh, and a large, flat, smooth stone. The flesh is commonly less juicy than that of the peach and of good quality. The apricot is little grown commercially in the Eastern United States, but is extensively cultivated in some of the more Western States, especially California. It is hardy wherever the peach is hardy, and some of the Russian varieties will stand even 1 or 2 degrees more cold than the peach. In the Eastern and Northern States only the best fruit growers succeed with the apricot. The difficulties in the way of the successful culture are its habit of early blooming and consequent liability to injury from late spring frost, as seen in Fig. 230, and the ravages of the curculio.

The apricot is grown either on peach, plum or its own roots. On suitable soils, *i. e.*, deep, loose, rich, well-drained loams, or in California on adobe or gravelly soils, it succeeds best on its own roots. On peach soils it is generally grown on peach roots, while on heavier soils it is grown on plum roots. Most of the apricot orchards in the United States are grown on peach roots. The apricot has an aversion to heavy, cold, wet soils and will not succeed on them.

Because of the early blooming habit of the apricot great care must be taken in selecting a suitable location and exposure for the orchard. This should be high, and, if possible, near a large body of water, since frosts are less serious in such localities. It is useless to plant trees on low, frosty ground. A northern or northwestern exposure is desirable because of its retarding effect on the blossoming period. On all lighter and drier soils nursery-budded peach stock is recommended. For the stiffer lands the New York Cornell Station is inclined to favor top-worked plum stock, that is, plum trees top-budded or grafted in the orchard with apricot.

The proper distance for setting the trees in the orchard is about 20 feet each way. Where nursery-budded trees are used the trees should be set low, so that, if possible, the union is below the ground. This lessens the danger of the tree breaking at the union and of injury from the root borer when peach stock is used.

The orchard treatment of the apricot is in general the same as that for peaches. The apricot is about as productive as the peach, and unless heavily thinned bears only in alternate years. In the East it is largely a dessert fruit, and should, therefore, be put up in small, tasty packages. In California it is one of the leading commercial fruits, and is extensively used for drying and canning.

There are 3 classes of apricots grown in the United States; the best, and the ones most largely cultivated, belong to the group *Prunus Armeniaca.* For the East, Harris, Early Moorpark and St. Ambrosie are among the best varieties for the early crop, and Moorpark, Royal, Montgamet and Turkish or Roman, for the midseason and late crop. In California, Royal is a favorite, followed by Blenheim, Hemskirk and the Peach. The hardy Russian sorts belong botanically to this same group, but, while very productive, they are smaller and of poorer quality and best suited for culture on the northern borders of the peach belt. The better varieties are Alexander, Gibb, Budd, Nicholas, Alexis and Catherine. The black or purple apricots form another botanical class, *Prunus dasycarpa.* The fruit is of a dull purple color, unattractive and sour, and clings rather persistently to the fuzzy pit. The Chinese or Japanese apricots belong to *P. mume,* and are chiefly grown for their ornamental blossoms, which vary from purple to dark red in color, and from single to very double.

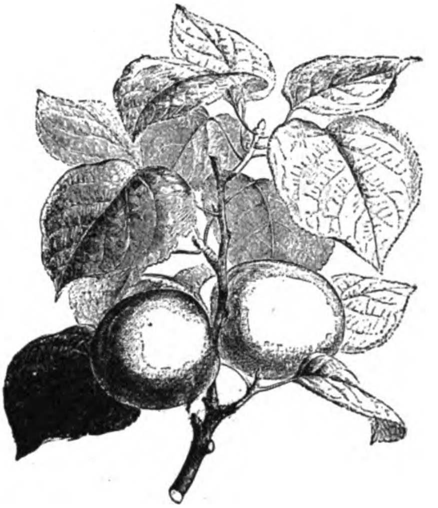


Fig. 229—FRUITING BRANCH OF APRICOT

There are a number of diseases and insects which attack the apricot. The most serious fungous disease is the collar rot. This is destructive to the trunk of the apricot. The disease begins just below the surface of the ground, where the bud is inserted, and affects the bark for a distance of a few inches above the union. Later the frunk may become discolored and the branches appear stunted. The cause of the trouble is not well understood, but it is suggested that the disease may be due to unfavorable soil and climate and imperfect union. For other fungous diseases see under *Plum* and *Peach.*

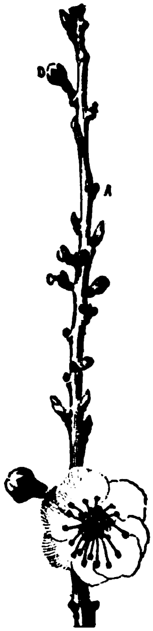


Fig. 230—WINTER INJURED APRICOT FRUIT BUDS

a, bud winterkilled; *b* and *c*, buds which will not be able to open; *d*, a weak blossom which cannot set fruit. Open flower only bud that can set fruit.
(N.Y. Cornell Expt. Sta. Bul. 181)

One of the most serious hindrances to the successful culture of the apricot is the plum curculio, for the treatment of which see under *Plum.* For twig borer see under *Peach.* For scale insects and plant lice see these subjects respectively.

BIRDS

An extensive popular literature has grown up during recent years around the subject of birds as related to agriculture. In various States laws have been framed restricting the time in which game birds may be destroyed and prohibiting the killing of a number of species of birds which are considered beneficial to agriculture. The question of the economic importance of birds has awakened widespread interest and a great deal of work has been done in the study of the feeding habits of birds, especially by the United States Department of Agriculture and at some of the experiment stations. As a rule these investigations show that the diet of birds consists to a considerable extent of injurious insects. The variations in the number of injurious insects in different years are striking, and are due to a number of conditions to which attention has been called by different writers. An exact estimation of the value of birds in this connection can hardly be made at present. The statement can be made concerning any particular bird that its food normally consists of certain percentages of injurious insects, beneficial insects, injurious weed seed, cultivated fruits, etc., and from this general statement a conclusion can be drawn as to whether the bird is on the whole beneficial or injurious to agriculture. In the case of many species great difference of opinion prevails among practical men on account of the great variety of food materials eaten by the birds according to local conditions. Hawks and owls in some localities are considered very injurious and bounties have been offered for their destruction on account of their depredations upon poultry yards. At the same time it should be remembered that these birds at other times of the year and in other localities destroy many injurious rodents, such as field mice, ground squirrels, gophers and rabbits.

The feeding habits of the robin were investigated at the Ohio Experiment Station, and it was concluded from this study that during the fruit season in the neighborhood of small fruit gardens these birds did more harm than good from their destruction of such a large quantity of fruit. A study of the feeding habits of the same bird in other localities at other times of the year gave the robin credit for destroying a large percentage of injurious insects. The English sparrow may be cited as another example of a bird of doubtful economic relations. In the vicinity of grain fields, when occurring in great numbers, the English sparrow is undoubtedly a pest. This bird, however, is a great enemy of the 17-year locust and dog-day locust and destroys great numbers of them. It is also known to feed upon other injurious insects.

Few birds of which the feeding habits have been studied have been found an unmixed good or evil, and the attitude of many practical farmers and gardeners toward this problem involves a feeling of the right to protect crops or poultry against the attacks of birds, and at the same time a disinclination to persecute or needlessly destroy these birds under forest conditions or in localities where they are not injurious to cultivated crops. During the winter season it is undoubtedly true that many species of birds destroy large numbers of injurious insects in the egg or pupal stage, and in so doing more than repay for any damage they may commit upon crops during the growing season. In general the ruthless destruction of birds without special reasons should be discountenanced by everybody.

BLACKBERRY (*Rubus villosus*)

Cultivated blackberries are coming more and more into use. Usually they sell the best of any of the small fruits. The yield averages 100 bushels per acre. They are used in the fresh state and for canning, but are seldom dried. Experiments at the New York Cornell Station show that from a bushel of blackberries not more than 12 or 14 pounds of dried fruit can be obtained. Berries sprinkled with granulated sugar dry better than those not treated.

A deep clay loam supplied with humus is the best land for blackberries. Sandy or gravelly soils dry out too easily at the critical period when the fruit is ripening. Blackberry plants should be set out in the spring. Suckers are usually used for this purpose. Plants are set 2 or 3 feet apart in rows 8 feet distant. Crops like potatoes or strawberries may be grown between the rows the first 2 years to pay for the use of the land. If the plants put out vigorously the first year 3 or 4 canes may be allowed to grow. These should be headed back when they have reached a hight of 2 or 3 feet by pinching off the tops.

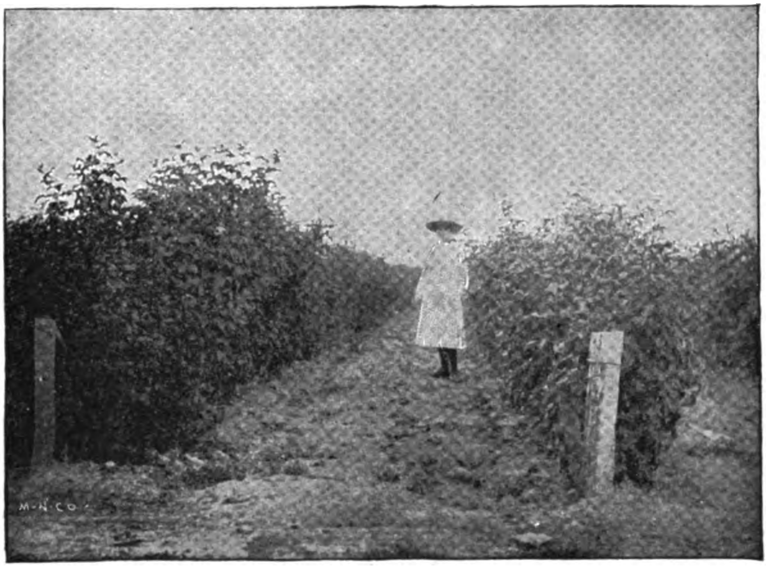


Fig. 231—EARLY HARVEST BLACKBERRY PATCH IN AUGUST
(From N. Y. Cornell Expt. Sta. Bul. 99)

The blackberry fruit is grown on canes which came from the roots the preceding season. After the fruiting season is over the usefulness of these canes or shoots is at an end and they should be cut out of the rows. This is performed preferably in the fall, but may be done any time before growth starts in the spring. While fruit is being produced on some canes, others are coming up from the roots. Usually only 5 or 6 canes from each root should be allowed to grow, the others being pulled out while they are still small. When the canes are 2½ to 3 feet high the tips should be cut or pinched back 2 or 3 inches. This stops upward growth and many laterals push out. These laterals bear the fruit the following season. They should be shortened somewhat in the spring, depending on the variety grown. Blackberries thus trained require no trellising. In bleak situations blackberries in the more northern sections will require winter protection. This is best done by laying the vines over and covering with earth 2 or 3 inches deep. Sometimes a trench is dug on one side of the rows 6 or 8 inches deep to facilitate laying down. Care should be taken not to crack the canes. The cost of laying down is about $10 per acre. In the spring, when danger from frost is past, the vines are righted. The blackberry patch should be plowed in the spring and given thorough shallow cultivation about once a week up to within a day or two of the time of picking, and once after picking. Well-rotted stable manure is the best fertilizer for blackberries.

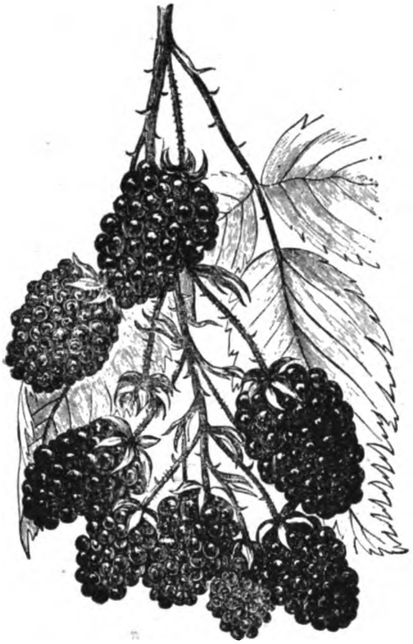


Fig. 232—KITTATINNY BLACKBERRY
(Reduced)

Blackberries produce a fair crop the first year after planting. The third year a full crop is probable, after which nearly uniform crops should be secured. A good plantation well cared for should last 20 years or more without renewing. The yields vary from 40 to 300 bushels per acre, depending upon the intelligence put into the business. Investigations at the Georgia Station showed that plats of blackberries over 6 years old gave decreased yields of from 58.9 per cent with Agawam to 25.6 per cent with Ancient Briton, as compared with plats of similar varieties only 2 years old. It is believed that in Georgia the blackberries should be renewed every 4 or 5 years.

Blackberries are divided by Bailey into 5 groups, as follows: Long cluster blackberries (*Rubus villosus*), which is the commonest large-fruited form of the wild blackberry, and is represented in cultivation by Taylor, Early Cluster and Ancient Briton; short cluster blackberries (*R. villosus sativus*), which is the commonest form of cultivated blackberries, and includes such popular varieties as Snyder, Agawam, Kittatinny, Erie and Mersereau; leaf cluster blackberries (*R. villosus frondosus*), which are dwarf bushes and known in cultivation by the varieties Early Harvest and Brunton Early; loose cluster blackberries (*R. villosus* x *R. Canadensis*), which are hybrids of the common blackberry and the dewberry; and sand blackberry (*R. cuneifolius*), a low variety 2 or 3 feet high, as yet not cultivated to any extent.

Some of the best varieties of blackberries, as regards productiveness, hardiness, freedom from rust, etc., for planting in the latitude of New York are Snyder, Ancient Briton, Agawam, Early Cluster and Taylor. The Georgia Station suggests Trinity Early, Early Harvest (Fig. 231), Kittatinny (Fig. 232), Early Cluster, Erie, Stone Hardy and Taylor Prolific as a succession for home use or local market in that State.

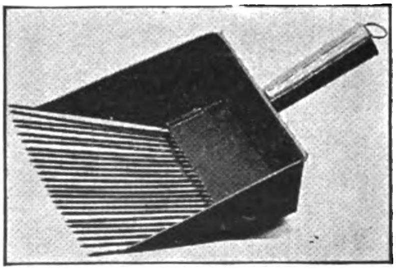


Fig. 233—BLUEBERRY RAKE
(From Me. Expt. Sta. Bul. 76)

For further notes on the culture of blackberries see N. Y. Cornell Expt. Sta. Buls. 57 and 99; also Ga. Expt. Sta. Bul. 33.

Enemies—LATE RUST (*Chrysomyxa albida*) appears in August and continues during the fall. It causes the formation of powdery, orange-red spots on the under side of the leaves. The disease is seldom so common or injurious as the spring rust and seldom requires treatment.

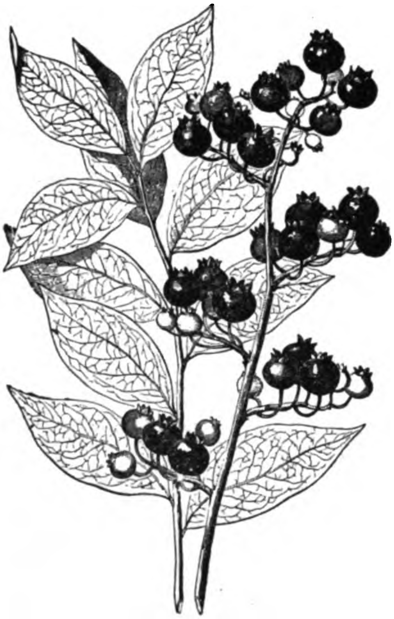


Fig. 234—HIGH-BUSH BLUEBERRY

YELLOW FALL RUST (*Uredo Mulleri*) is quite injurious in some parts of New York. It appears in May as bright yellow spots on the canes near the surface of the ground or higher up. In August the rust appears on the leaves. But little damage seems to result from the presence of this rust.

Other fungous diseases and insect enemies are discussed under *Raspberry*.

BLUEBERRY (*Vaccinium* spp.)

Experiments have been undertaken in Maine, New York and Massachusetts for the improvement of blueberries and the handling of blueberry barrens. The high-bush blueberries usually grow on moist lands and do not take kindly to garden cultivation, though a few reports show that by care success may be attained and the fruit much increased in size and yield under cultivation. In many of the Eastern and Northern States extensive blueberry barrens occur on lands which are, as a rule, too poor for other agricultural purposes. The blueberry bushes in these barrens are low, scarce exceeding a foot in hight, and frequently bear heavy and profitable crops. A systematic treatment of these barrens has been reported by the Maine Station. The barrens reported upon cover an area of 40,000 acres and belong to one owner. About 1-3 of the barrens is burned over every spring to renew the bushes and keep down underbrush. The burning is done very early in the spring before the ground becomes too dry in order that the fire may not run too deep, which would burn out the humus in the soil and ruin the barrens. The fire is spread by having a workman pass around the area to be burned, dragging after him an ordinary torch. This is the only care given. The first fruits to ripen are picked by hand and sent to the city markets usually in quart boxes. Later in the season the fruit is sent to the canneries. On the older barrens, especially on areas to be burned over the following spring, the fruit is gathered with a blueberry rake. This is a rake made something like a dustpan, the bottom of which is composed of stiff parallel wire rods, as seen in Fig. 233. The fruit is gathered quickly and cheaply by means of this rake, but the bushes are seriously injured by the treatment, and it should, therefore, never be used with high-bush blueberries.

Blueberries and huckleberries are interchangeable terms, but blueberries properly belong to the genus *Vaccinium* and huckleberries to the genus *Gaylussacia,* especially *G. dumosa* and *G. resinosa.* The species most commonly found in New England are, in the order of their commercial importance, *Vaccinium Pennsylvanicum, V. Canadensis, V. corymbosum, V. nigrum* and *V. vacillans.* The high-bush blueberry is *V. corymbosum.* (Fig. 234.)

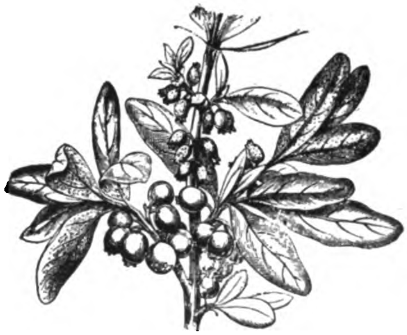


Fig. 235—BUFFALO BERRY

BUFFALO BERRY (*Shepherdia argentea*)

A native shrub fruit of the Western plains and Rocky Mountain States. The fruit is small, quite acid, either bright red or yellow, and has small seeds. It is not considered of importance where currants will grow, but has a value in the drier portions of the Northwest where the culture of the better bush fruits is precarious. The plant is propagated either by seeds, cuttings or suckers. The male and female flowers are borne on separate plants. This necessitates care in transplanting to see that both kinds of plants are set, as otherwise no fruit will be obtained. The plant is quite ornamental and is sometimes recommended as a hedge plant for the Northwest. (Fig. 235.)

CHERRY (*Prunus* spp.)

The cultivated cherries are divided into 2 general groups, sour and sweet. The sour cherries (*Prunus cerasus*) are the more generally and widely grown. They are used largely for canning and pies. The trees are low, round-headed and hardy in nearly all parts of the country. They do especially well in Northern and Eastern States, and even as far south as Oklahoma the experiment station reports them as doing well on nearly all kinds of soil. The New York Cornell Station recommends strong, loamy soil which is retentive of moisture as the most suitable for sour cherries.

Sweet cherries (*P. avium*), when grown naturally, make tall, pyramidal trees, sometimes 40 to 50 feet in hight. The fruit is generally heart-shaped and sweet. The tree grows vigorously and will succeed in soils where other fruit trees will not thrive. In general a deep and naturally dry gravel or sandy loam of good quality and located at an elevation where there is good air drainage is recommended. Too rich soil should be avoided, as under these conditions the trees tend to wood growth, cracking of the bark and non-bearing.

Cherries are propagated by budding or grafting trees of various hardy sorts grown from pits. In the Eastern States the Mazzard (*P. avium*) is considered the most satisfactory stock for both sour and sweet varieties. The Mahaleb stock (*P. mahaleb*), though more easily worked and more generally used than Mazzard, does not produce so long-lived trees, and has been shown by the Iowa Experiment Station to form a less perfect union with the wood of the improved varieties. In Iowa, Prof. Budd has shown that the Mazzard can be safely used as a stock only in crown-grafting, using long cions and planting in the nursery down to the top bud. By this method 9 out of 10 trees set are rooted from the cion in the nursery when 2 years old. Cions for grafting must be kept dry until used. If they absorb water and swell the buds or callus they will fail to unite with the stock. After grafting the grafts should be packed in boxes with sand or moss and kept in a cool cellar. If the buds start into growth before the grafts are planted out in the nursery row they usually fail to grow. Sprouts from deeply set trees of Mazzard stocks are true to the varieties planted.

Another excellent stock for the improved cherries is Morello. Vigorous trees grow from the pits of the true Morellos when kept in sand over winter where they will freeze. These trees have proved excellent stocks for all the hardy varieties of cherries grown in the West thus far tested by the Iowa Station. Wild red cherry (*P. Pennsylvanica*) has also been found by Prof. Budd to unite perfectly with the Morello, Duke and Heart cherries. The sand cherry (*P. pumila*) has been found a hardy stock, a rapid upright grower as easy to work as Mahaleb, and it does not dwarf the sorts grafted upon it. Root-grafting is considered much more satisfactory than propagation by budding. The plan of alternating rows of different varieties of cherries to insure proper pollination is also favored.

Cherry trees should be set in the orchard when 2 to 3 years old; sour varieties 18 feet and the sweet varieties 30 feet apart each way. The sour cherry comes into bearing in 3 years and the sweet varieties in about 5 years after setting in the orchard. Paying crops are secured at about 10 years. The tops should be started at about 3½ to 4 feet from the ground. The sweet cherry should be pruned to 3 or 4 main arms for 2 or 3 years to give it a more spreading or apple-tree form, after which only the dead and interlacing branches need to be removed and a certain amount of shortening is practiced to give the trees a low, bushy form.

The cherry orchard requires clean and frequent cultivation until the fruit is ripe, after which the land may be seeded to some cover crop. This should be plowed under as early in the spring as the ground can be worked, the same as in the apple orchard. Small fruits like raspberries, currants and gooseberries, and certain other crops that require cultivation, may be grown in the orchard for the first few years, but these should be more and more restricted to the space between the rows as the cherry trees develop.

Stimulating or nitrogenous manures should be used cautiously. The growing and plowing of nitrogenous cover crops will generally furnish all the nitrogen required by the cherry orchard. Potash, according to the New York Cornell Station, is best furnished in applications of wood ashes or in muriate of potash, using 250 pounds per acre of a 50 per cent muriate. This should be applied in the spring and harrowed in. Phosphoric acid may be applied in the form of ground bone or South Carolina or Florida rock, using 250 pounds per acre in the same way as the potash. With clean culture the cherry orchard will seldom need heavy fertilizing.

In harvesting cherries for market they should be picked with the stems on a few days before ripe and kept in a cool place. The fruit should not be touched with the fingers. The New York Cornell and Delaware Experiment Stations recommend the use of 8-pound baskets, with smaller sizes for fancy fruit. Good pickers can earn from $1.50 to $2 per day at 1 cent per pound.

Varieties—Only a few of the better varieties are here noted. Of the pale red sour varieties Montmorency and Early Richmond are recommended; of the dark red, the various Morellos (Fig. 236), Ostheim and Louis Philippe. Of the sweet varieties the following are recommended by the New York Cornell Station: For market, Windsor, Napoleon, Black Tartarian, Black Eagle, Mezel, Robert Red Heart, Downer Late Red; for home use, Black Tartarian, Governor Wood, Coe Transparent, Belle d'Orleans, Downer Late Red, Black Eagle, Knight Early Black, Napoleon, Rockport, Robert Red Heart, Yellow Spanish, Windsor, May Duke and Belle de Choisy.

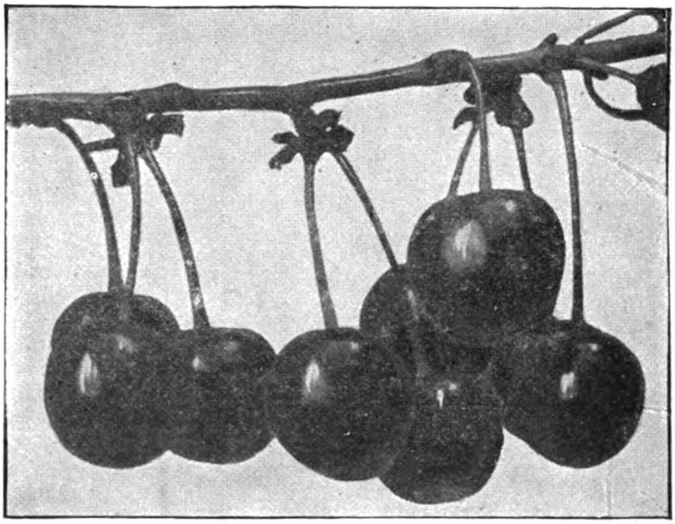


Fig. 236—ENGLISH MORELLO CHERRY
(From N. Y. Cornell Expt. Sta. Bul. 98)

Russian Varieties—In some of the more Northern regions and in regions subject to late spring frosts some Russian varieties of cherries have proved successful where common sorts fail. These cherries possess a dwarf, compact habit of growth and blossom and ripen their fruit later than common sorts. The following varieties have given the best results at the Michigan Station: Bessarabian, very hardy and prolific; Brusseler Braune, fruit large, tree vigorous and prolific, and Ostheim, one of the best known of the Russian varieties.

Other Sorts—A few other cherries may be briefly noted. The Western dwarf cherry (*P. Besseyi*), found upon the plains beyond the Mississippi and extending into the mountains of Colorado and Utah, is considered a fruit of great promise for cultivation. Improved Dwarf Rocky Mountain cherry is a variety of this species which promises much as the parent of a new type of cherries which from their very dwarf habit will be adapted to small gardens. The Wild Black cherry (*P. serotina*) is a valuable ornamental and forest tree in many States. It has made very satisfactory growth at the Minnesota and South Dakota Experiment Stations. The chokecherry (*P. Virginiana*) is a small shrub with very astringent fruit and valuable only from an ornamental point of view. The Western chokecherry (*P. demissa*) is a shrubby plant which produces fruit having an agreeable taste closely resembling that of the black cherry. These are free from astringency and are frequently used by settlers for jellies, pastry, etc. (See also N. Y. Cornell Expt. Sta. Buls. 38 and 98; Iowa Expt. Sta. Bul. 10; Mich. Expt. Sta. Bul. 123, Russian cherries.)

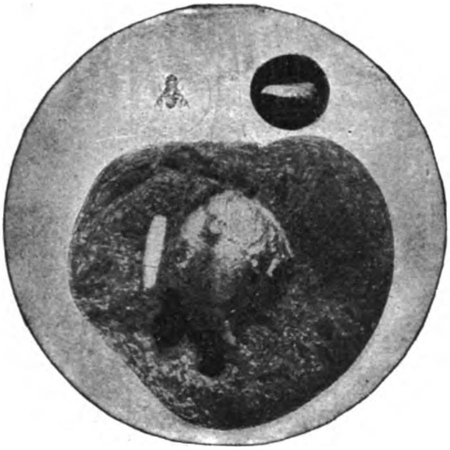


Fig. 237—CHERRY FLY
(From N. Y. Cornell Expt. Sta. Bul. 172)

Enemies: BROWN ROT—See under *Peach.*

BLACK KNOT—See under *Plum.*

POWDERY MILDEW—See under *Apple.*

LEAF SPOT—See under *Plum.*

RUST—See under *Plum.*

SCAB—See under *Plum.*

LEAF CURL (*Exoascus pruni*) causes the formation of dense tufts of twigs from a single point. No fruit is borne on these so-called witches' brooms and the leaves are yellow or red. Affected parts should be cut out and burned.

CURCULIO—See under *Plum.*

CANKER WORM—See under *Apple.*

SLUG (*Selandria cerasi*) in the adult condition is a black 4-winged fly, which lays its eggs in the leaves. The larvae, which become full grown in about 4 weeks, are of a shiny dark green color and eat the leaves except the large veins. Dusting the trees with hellebore, pyrethrum or air-slaked lime or spraying with the arsenites will destroy these insects.

For APHIS see *Plant Lice* under *Cabbage.* The cherry is also attacked by several species of scale insects, tent caterpillars, etc. For the latter see under *Apple.*

CHERRY FRUIT FLY (*Rhagoletis cingulata*) is a 2-winged fly with black body and 4 black bands on each wing. (Fig. 237.) The maggots are light yellow and have a fan-shaped organ near the head. The maggots mine through the pulp of the cherry and their presence is not always detected at picking time. Domestic poultry in the orchard will destroy many of the maggots, and since the insect passes a long time in the soil it could be destroyed to some extent by thorough cultivation in the fall.

CHESTNUT (*Castanea* spp.)

The growing of chestnuts for profit is a recent industry in this country which has been stimulated by the introduction of Japanese varieties. Native sweet chestnuts (*Castanea Americana*) grow wild in forests from Maine to Michigan and south to Georgia. The nuts rank first in quality, but are much surpassed in size by both Japanese and European varieties. The biggest nuts bring the best prices, therefore the bulk of the commercial chestnut orchards now planted are made up largely of European (*C. sativa* or *vesca*) and Japanese (*C. Japonica*) varieties.

Propagation—Chestnuts are propagated from seed planted either in the fall or spring and the seedling trees later grafted or budded with improved varieties. Nuts intended for seed must not be allowed to dry out or they will not germinate. When kept over winter for spring planting they should be preserved in a box buried about 6 inches deep in the open ground and alternating in single layers with moist sand. The trees have a long tap root which makes them somewhat difficult to transplant, therefore when possible it is advisable to plant the nuts where the trees are to stand. In the nursery the trees are grown in rows

4 feet apart, 18 inches distant in the row. When 2 years old they are grafted. The Connecticut Experiment Station found that the best time for grafting chestnuts in that latitude was between May 15 and June 15. At that station whip grafts made the best unions on small stocks and cleft grafts on large stocks. Either root, crown or stem grafting (see *Grafting*) may be practiced, and each method has its advocates. The chestnut graft is somewhat difficult to make and the technique of the work must be carefully done. Under favorable conditions 50 per cent of the cions set may be expected to grow.

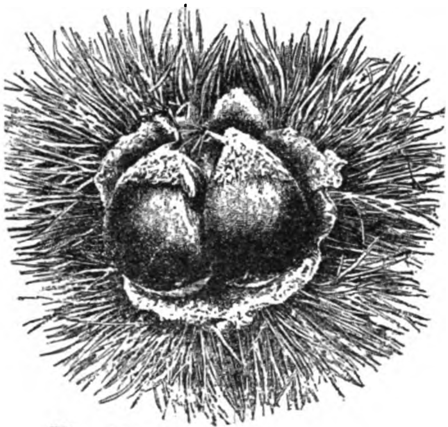


Fig. 238—OPEN BUR OF RIDGELY CHESTNUT

The following fall or spring, after the trees have been grafted in the nursery row, the trees may be transplanted to their permanent places in the orchard, the European varieties 40 feet and the Japanese 30 feet apart each way. The tap root should be cut back to 18 inches and the tree pruned to an open, spreading form, with 3 to 5 main branches. Cultivation should be practiced similar to that given a young apple orchard.

Grafting Over Stump Lands—On many farms where native chestnut trees are abundant the practice has been profitably followed of cutting down the native trees and grafting the sprouts which arise from the stumps and roots, when they have attained a thickness of 2 to 3 inches, with the improved forms. This is a rapid and one of the most satisfactory ways of securing a chestnut orchard, and where it is possible to do it the method is strongly recommended. Many farmers have chestnut woodlands or lots too wild to be cultivated which might be made sources of profit by converting them into improved chestnut orchards. Chestnuts do well on nearly any soil, whether light sand or heavy clay, that is well drained. This last is essential and failure will surely result if the trees are set on badly drained and wet lands.

Grafted chestnut trees grow rapidly and Japanese varieties frequently set fruit the first year of the insertion of the cion, and both Japanese and European varieties frequently bear heavy loads of burs the second year. Good growers find it advisable to pick off all burs for the first 3 or 4 years in order to give the trees opportunity to become well established and vigorous before the strain of reproduction begins.

Varieties—The relative merits of Japanese and European chestnuts are summarized by the Delaware Experiment Station as follows: With the Japanese varieties the trees come early into maturity, are easily cared for and are enormously productive. The fruit ripens early and the nuts are large. They are the money-makers in large groves. The trees are practically free from blights, are less affected by worms than the European, make perfect unions on American stocks and have a considerable ornamental value. On the other hand, the trees have a tendency to overbear, the nuts are often of poor quality and some make a delicate growth. Among the better varieties are Alpha, Reliance,

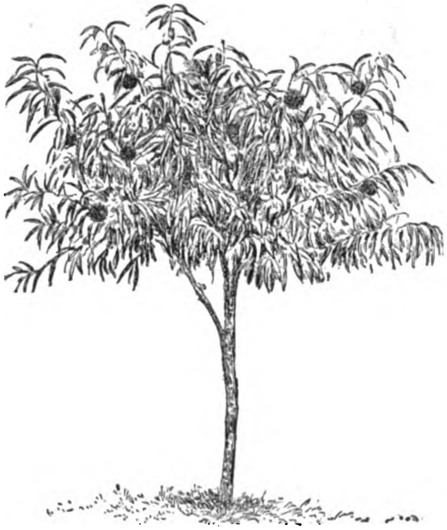


Fig. 239—FOUR-YEAR-OLD PARAGON CHESTNUT TREE

Perry and Ridgely. (Fig. 238.) With the European sorts the great productiveness of some varieties, timber value of trees, finer quality and appearance of the nuts and the prolific bearing of a few are stated as the advantages of the group, while the disadvantages are the late maturity of the trees and late ripening of the nuts of some varieties, shy bearing of many when young, largeness of bur, which may become water soaked and break the trees, and greater susceptibility to leaf blight and weevil attacks. They do not compare with the Japanese in commercial groves as money-makers. One of the best European varieties is Paragon. The trees of this variety are prolific, the nuts large and of good quality. Another desirable variety is Numbo. Paragon has proved the most satisfactory variety grown in Michigan. A 4-year-old tree of this variety is seen in Fig. 239.

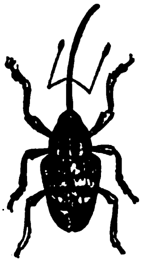


Fig. 240—CHESTNUT WEEVIL

Enemies: Leaf Spot (*Septoria ochroleuca*) attacks young trees in the nursery and also old trees. It appears as numerous bright spots on the leaves, which later turn brown. The disease may be controlled by spraying with Bordeaux mixture. Chestnuts are subject to the attacks of an anthracnose which is seldom serious.

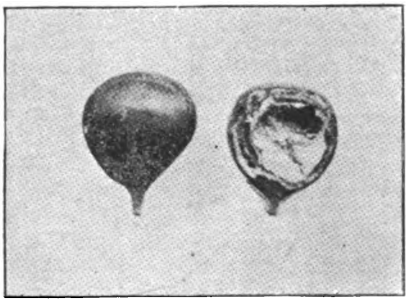


Fig. 241—CHESTNUTS INFESTED WITH WEEVILS
(After Felt)

The chief insect injuries to chestnuts are due to 2 weevils (*Balaninus proboscideus* and *B. rectus*). Both weevils have long snouts. The first species is the larger and bears yellow lines and spots on the thorax. The general color of the second species is light brown. The adults of both weevils appear about the blossoming time of the chestnuts and deposit their eggs, which hatch into the well-known grubs that live in the nuts. The second species also infest chinkapins and acorns. All infested nuts should be destroyed before the grubs have opportunity to escape to the ground, or they may be fumigated with carbon bisulphid (1 pound to 1000 cubic feet of space). The perfect insect is seen in Fig. 240, and nuts affected by its work in Fig. 241.

CHINKAPIN (*Castanea pumila*)

This is a dwarf chestnut. It grows wild on sandy knolls and hillsides from Florida north to Delaware, west to Indiana and southwest to Eastern Texas. It is a spreading shrub or small tree, sometimes attaining 20 to 30 feet in hight, though the shrub is more usual. The nuts are borne singly in chestnut-like burs. They are smaller than chestnuts, are produced more abundantly and ripen considerably earlier, and for this reason reach the market first and sometimes bring higher prices than chestnuts.

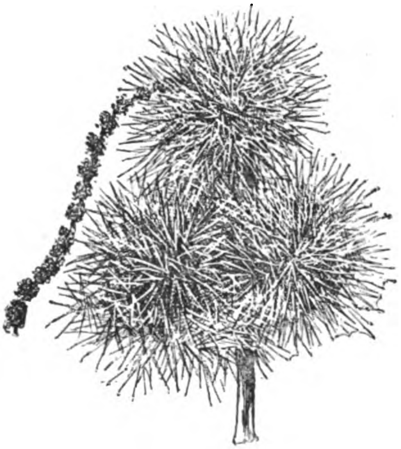


Fig. 242—THE FULLER CHINKAPIN

The Western chinkapin (*C. crysophylla*) is found in the Cascade, Sierra Nevada and Coast Range mountains below 4000 feet elevation, and in Oregon. In some counties of California it forms a large tree 50 to 125 feet high and 2 to 3 feet in diameter. The more abundant form, however, is a small shrub 2 to 6 feet high. So far as known there is only 1 improved variety of chinkapins under cultivation, a cluster of burs of which is seen in Fig. 242. The insects and diseases affecting these nuts are the same as for chestnuts. (See *Chestnut.*)

CITRUS FRUITS (*Citrus* spp.)

These fruits are produced in this country in commercial quantities in California, Florida and Louisiana. California is the State of largest production. In 1900 there were over 3,500,000 orange trees growing in that State alone, and 1/4 as many lemon trees. There were also about 16,000 lime and 24,000 pomelo trees. The total shipment of citrus fruits for that year reached 226,547 tons. The severe winter of 1899, which ruined many Florida and Louisiana orchards, has greatly reduced the production in those States, but the orchards are being rapidly built up again. The more important citrus fruits in cultivation in these States are the orange, lemon, lime and pomelo. The cultural requirements of these will be noted in the order of their commercial importance.

Orange (*C. aurantium*)—The orange requires a practically frostless situation. It cannot be grown profitably for fruit in localities where the temperature frequently falls below freezing. A rich, warm, well-drained soil, preferably alluvial loam, is the one most generally recommended for the orange orchard.

The orange is almost exclusively propagated from seed, though sometimes by cuttings and layers. Good, plump seed selected from home-grown fruit may be used for producing seedlings for budding or for growing in the orchard for their own fruit. Though not now planted to any extent, there are many profitable seedling orchards. Varieties, however, are not certain to come true from seed, and budding is therefore quite generally resorted to. Orchard seed for propagating should never be allowed to dry out. If not planted immediately it should be mixed with moist sand and stored until warm weather comes in the spring, when it should be planted either in boxes or outdoor beds filled with a good sandy loam. The seed may be sown broadcast or in drills. They should not be less than 1½ inches apart. Cover about an inch deep and keep the ground moist. The seedlings appear in about 6 weeks and will be ready for transplanting to the nursery the following spring. In the nursery the trees should be set from 9 to 18 inches apart in rows sufficiently wide to permit of horse cultivation. About the same cultivation is practiced as with deciduous fruit trees. The following spring the seedlings will be ready for budding. This should be done as soon as the trees are in good sap, though budding in summer and fall is also sometimes practiced. Well-matured spring buds taken from near the middle of the shoot should be selected. The method of budding is the same as with deciduous fruits (see under *Grafting*), except that the cross cut in the bark of the stock should be made in the form of an inverted T. As soon as the buds start the tops of the stocks are cut off a little above the bud and all suckers below the bud kept removed. The growing shoot should be tied to the stub of the stock for protection.

Several species of citrus fruits are used as stock for the orange. The large majority of growers in the low alluvial districts of Louisiana prefer sour stock. This stock is also preferred in Florida on low lands inclined to be wet. Sour stock is entirely free from diseases, especially the disease known as foot rot, sour shin or "mal di goma." It is a vigorous wild tree and when budded with sweet oranges bears crops at an early age. In California, Florida sour stock is considered as good as sweet stock. It is a much deeper rooted stock than sweet stock, and on this account may prove of special value in localities where the sweet stock fails.

Sweet orange has been quite generally used in California, and is claimed to be as good as any. The stock is a persistent surface feeder, thus making it very susceptible to drouth. It is being superseded in lower California by pomelo stock. In Florida and Louisiana, where moisture is more abundant, it has the merit of long life and thriftiness on dry, thin soils, where the sour orange will not succeed. It has, therefore, found favor on the poorer classes of high pine lands. A serious objection to this stock is its susceptibility to foot rot. Pomelo stock in Florida stands next to sour orange in popularity and is rapidly gaining in favor in California. Rough lemon is frequently used as a stock in Florida, but is too tender for the northern limits of orange growing.

In the nursery the budded trees should remain 1 to 2 years; they may be transplanted to the permanent orchard at almost any time, but from December to March is the time usually advised in the South. Prepare the orchard by plowing and thorough cultivation. In California the station advises that the soil be worked at least a foot deep and that a subsoiler be used to loosen the soil several inches deeper. Seedling trees should stand 30 to 40 feet apart each way, standards 24 to 30 feet, semi-dwarfs, like the navels, 18 to 24 feet, and dwarfs about 10 feet. When the trees are removed from the nursery it is the almost universal practice to cut off a large part of the top, leaving only short stubs of branches. Sometimes the leaves are also removed from these. This balances up in a measure for the partial loss of the roots in digging the trees. Great care should be taken that the roots are not exposed to the hot sun or to drying winds. In California many growers puddle the roots as soon as the tree is dug by dipping them into a thin pudding-like mixture of loamy clay soil and water. The roots are then packed in wet straw and the straw kept moist until the trees can be planted. Another safe way in dry regions like California is to water the trees thoroughly and then remove direct to the orchard with a large ball of earth attached to the roots. The trees should be planted to about the same depth that they stood in the nursery.

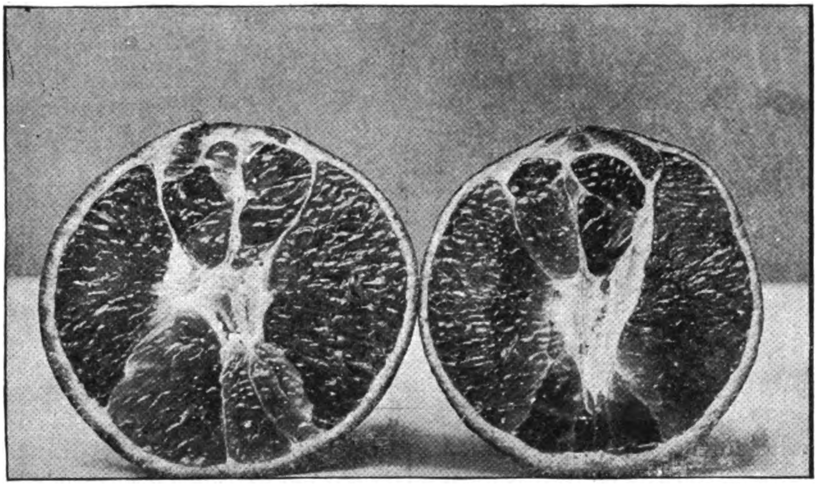


Fig. 243—CROSS SECTIONS OF NAVEL ORANGE

The orange orchard requires frequent cultivation. In Florida clean cultivation is practiced until June, when the orchard is left to grow up to crab grass and beggarweed. In Louisiana nearly every grower sows cowpeas at this time as a cover crop. In the irrigated districts of California the station advocates deep plowing north and south one year and east and west the next, followed by frequent deep cultivation throughout the season. The depth of cultivation should be varied from year to year to avoid the formation of hardpan. The station recommends a depth of 8 inches, 12 inches, 10 inches, 14 inches, and then 8 inches again in succeeding years. Water should be run on slowly in deep, narrow furrows and be followed immediately by cultivation.

Orange trees require but little pruning other than the removal of undesirable branches and dead limbs.

It sometimes becomes necessary to work over old orchards with more desirable sorts. This is usually done by budding. All branches not used for budding are cut out and the remaining branches thinned above where the buds are inserted. The rebudding should take place in the spring, and preferably with "cured" buds. These are buds taken from trees a few weeks before using and kept in damp moss. This curing toughens them up and makes them more easy to handle, and they seem to "take" better. When the buds have "taken" and the bands about them removed the whole top of the tree should be cut off and the remaining trunk and stubs whitewashed to prevent sunburn. The cut surfaces should also be covered with grafting wax or putty. Sometimes 1 branch is left to draw sap into the tree and to afford shade to new shoots. This is a safe practice, but if the budding is well done it is hardly necessary.

Creole seedlings make up the bulk of Louisiana orange orchards. Other varieties which are being rapidly introduced are Brazilian and Jaffa. The following are favorite varieties in Florida: Jaffa, Majorca, St. Michael, Stork, Seedless, etc. In California the Washington Navel and its subvarieties are the chief commercial varieties now grown. (Fig. 243.)

Lemon (*Citrus medica* var. *limon*)—The lemon is especially sensitive to frost and cannot be successfully grown where it occurs. Its range of culture is therefore much more restricted than the orange. The best soil for the lemon is a sandy loam, but it has been successfully grown on nearly all soils. It is usually propagated by budding on orange stock, since this stock adapts itself to a greater variety of soils and produces a vigorous, healthy tree where lemon stock would fail. The growing of the seedlings, treatment in the nursery, budding, etc., of the lemon is the same as for the orange. In the orchard lemon trees should stand 20 to 24 feet apart each way. Old trees or undesirable varieties may be topworked by cutting off the limbs in the spring and budding the young shoots that grow from the stubs the following year. The lemon tree should be headed low, otherwise it requires but little pruning. In California, Lisbon, Villa Franca and Genoa are favorite varieties, and in Southern United States, Villa Franca, Belair, Premium, Sicily and Genoa.

Pomelo (*Citrus decumana*)—The commercial term grape fruit is synonymous with pomelo, while shaddock, a term sometimes used for these fruits, is more properly applied to a large pyriform or necked variety of the pomelo. This variety sometimes reaches a weight of 15 pounds or more. Within the past few years the smaller pomelo has become very popular in Northern markets and extensive orchards are being rapidly set out in Florida, which is the State of largest production. The pomelo is somewhat larger than the orange and of a pale yellow color. The membrane dividing the pulp is bitter and the pulp pleasantly sub-acid. The fruit is becoming a popular morning dessert fruit. A typical form of improved pomelo is seen in Fig. 244.

The culture of the pomelo is similar to that of the lemon and orange. Among the better varieties are Aurantium, Marsh Seedless and Pernambuco.

Lime (*Citrus medica* var. *acida*)—This is a small bush 10 to 20 feet high, which produces spherical or elliptical fruits a little smaller than the lemon. The fruits are very acid and slightly tinged with bitter. The lime is less resistant to frost even than the lemon. It is cultivated to some extent in Florida, where in the southern parts it also grows wild, and in California. Limes usually come true from seed and are propagated in that way.

Enemies—In Florida the most important diseases of citrus fruits are foot rot or gum disease, die back and sooty mold. In California the worst troubles are gum disease, scaly bark, die back and orange and lemon rot.

FOOT ROT OR GUM DISEASE attacks the crown and main roots. It is first recognized by an exudation of gum with a foul odor. Later the bark over the diseased area dries up. The tree continues to bear fruit, but is unthrifty, and the leaves turn yellow. Pasturing, deep setting, poor drainage, overirrigation and excessive use of manure are conditions favorable to development of the disease. Affected parts should be cut out and burned. The cut surface should then be painted with 1 part crude carbolic acid in 4 parts of water, or with some other antiseptic solution. Sour orange, pomelo and rough lemon are quite resistant, while sweet orange is very susceptible.

SCALY BARK is a form of gum disease which prevails in Southern California. It attacks the trunk and some of the branches. The disease penetrates to the center of the trunk and soon kills the tree. The sour orange and pomelo are also resistant to this disease. The same treatment should be adopted as for foot rot.

SOOTY MOLD appears on the leaves, fruit and twigs as a black, velvety coating. The mold is easily rubbed off. The fungus is not parasitic, but lives upon the honeydew which is secreted by plant lice and scale insects. The mold interferes seriously with the growth of the tree by shutting out the light. Spraying with resin wash is effective. Three applications should be made between December and March. The insects will thus be killed and the mold will find no honeydew on which to grow.

Die Back may be known by the twigs turning yellow, the leaves falling off and the new growth dying back to the old wood, on which brown eruptions appear. Later the old wood also dies. Underlying hardpan, impervious clay or overirrigation are predisposing causes of this trouble. These conditions produce faulty nutrition in the plant. Withholding organic fertilizers and attention to drainage have a tendency to prevent the disease.

Orange and Lemon Rot causes a softening and discoloration of the fruit with the development of a disagreeable flavor. The disease may appear in the orchard, but the fruit usually becomes affected after picking. Navel oranges are subject to this rot in the orchard. The disease may be largely prevented by cold storage, good ventilation of storehouses, wrapping the fruit with tissue paper and destruction of all rotten fruit. (See Cal. Expt. Sta. Buls. 138 and 139, and Fla. Expt. Sta. Bul. 53.)

The most important insect pests of citrus fruits are bark lice, especially purple scale, Florida red scale, California red scale, white scale, chaff scale, orange scale, San Jose scale, etc. (See *Scale Insects.*)

Rust Mite (*Phytoptus oleivorus*) is a 4-legged mite of minute size, which punctures the oil cells of oranges, causing a discoloration of a rusty red appearance, which is due to an exudation and drying of the oil upon the surface of the orange. In warm weather the eggs, which are laid in clusters on the surface of the leaves, hatch in 4 or 5 days. When food becomes scarce the mites migrate and travel for considerable distances. Since the mites are not protected by any covering of plant substance, they may be readily destroyed by spraying with contact insecticides. Whale oil soap, 1 pound to 50 gallons of water, is effective if several applications are made at short intervals. The 6-spotted mite may be controlled in the same way.

Orange Sawyer (*Elaphidion inerme*) is a dark brown beetle, with long antennae. The grubs are white, with rudimentary legs, and when full grown are about 1 inch in length. They burrow in the branches of orange trees. Usually this insect feeds by preference on dead branches of the orange, hickory and other trees. The grubs may be destroyed by pruning off and burning infested branches or by the use of a wire which may be forced into the burrows.

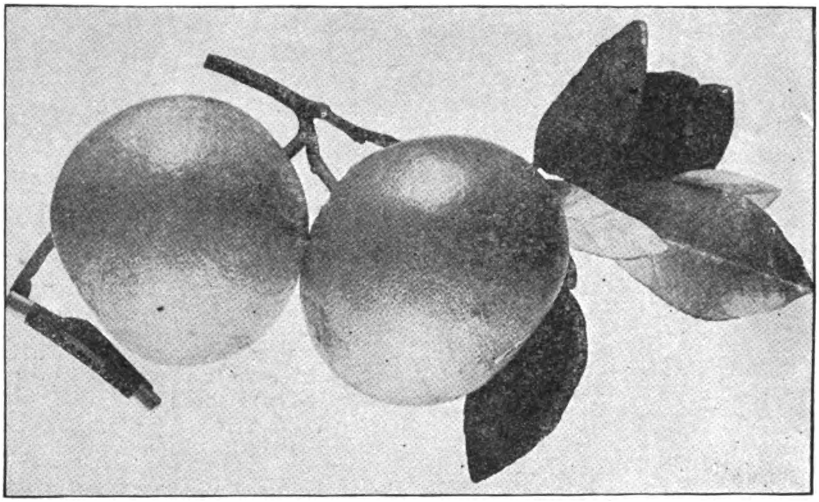


Fig. 244—LEAVES AND FRUIT OF POMELO
(From Fla. Expt. Sta. Bul. 58)

White Ants (*Termes flavipes*) are whitish, soft-bodied insects, resembling ants and living in large colonies. They usually feed on dead wood and decaying vegetable substances, but occasionally attack living plants, especially the parts which lie below the surface of the ground. On orange trees the first attack is made near the ground and is to be recognized by an exudation of sap from the wounded bark. Extensive mulching and the use of decayed wood as a fertilizer in orange groves furnish favorable conditions for the development of these insects. White ants cannot endure exposure to sunlight and therefore the earth should be removed from the base of affected trees. Hot water, kerosene emulsion or bisulphid of carbon may be used for destroying colonies in the manner recommended for ordinary ants.

Citrus fruits are also subject to attacks of plant lice, leaf-eating caterpillars, thrips and various species of leaf bugs, besides a number of other insects of less importance.

CRANBERRY

Cranberries grow wild in this country in swamps and boggy marsh lands. There are 2 species. Both are low trailing vines, which bear firm red berries that ripen late in the fall and sometimes persist on the vines until spring. The smaller cranberries (*Vaccinium oxycoccus*) are frequently gathered wild for home use and the market, but it is the larger sorts (*V. macrocarpon*) which are grown so extensively by Cape Cod, New Jersey and Wisconsin growers for the commercial market. (Fig. 245.) Cranberries are used for sauce, jelly and like purposes, and are universally served with turkey in the United States on Thanksgiving day.

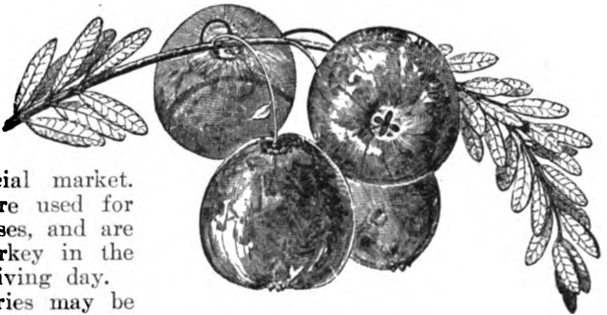


Fig. 245—THE LARGE CRANBERRY

A plantation of cranberries may be made on either low or high ground, but permanent success is more likely to follow where low boggy ground is used and in localities where the crop grows naturally. According to Prof. Bailey, the ideal bog for cranberry culture is the one in which the natural environments of the plant are most nearly imitated and in which the grower can have the greatest control. It should have the following qualifications: "(1) Capability of being drained of all surface water so that the free water does not stand higher than 1 foot below the surface in the growing season; (2) soil which retains moisture through the summer, for cranberries suffer greatly in drouth; (3) sufficient water supply to enable it to be flooded; (4) a fairly level or even surface, so that the flooding will be of approximately uniform depth over the entire area; (5) not overliable to frosts. Bogs which contain moss or sphagnum and which have a peaty or mucky soil are usually chosen. If heath-like shrubs grow naturally in the bog the indications are all the better. The presence of the Cassandra or leather-leaf is regarded as a good augury. Black ash, red maple, swamp huckleberry and white cedar swamps are often very satisfactory. Old mill ponds often give good results." (Cyclopedia of American Horticulture.)

Cranberry bogs are prepared by first clearing away all trees, moss and roots. The wild moss and grass growth is removed either by turfing the soil, that is, cutting the moss, roots, etc., into small squares and removing the whole down to the clean muck, or by flooding for a season and drowning out the wild growth. The former is the more costly, but much the more satisfactory way. The bog is then ditched to carry off the surface water. One or more main open ditches are run through the central portion of the bog and laterals drained into these. The ditches are made 2 to 4 feet deep, and if water stands in them to within a foot of the surface better results are expected. The lower end of the main ditch is arranged so that it can be closed by a dam which will back up the water and flood the bog in winter. It is desirable that the bogs be covered with water a foot deep or more from December to April or May. This protects the plants from heaving during winter and helps drown out insects. The bog is frequently flooded to avoid early spring and late fall frosts, as a protection from fire and in times of drouth. Where sufficient water is not available from the streams or ditches running through the bog it is desirable that a reservoir be constructed above the bog and kept filled with water for flooding purposes.

In some localities cranberry vine cuttings 6 to 8 inches long are planted directly on the muck bed, but the usual method of Cape Cod and Wisconsin growers is first to cover the entire muck surface about 4 inches deep with clean sand. The vine cuttings are then thrust down obliquely through the sand into the muck in rows about 14 inches apart each way. This sand layer keeps down weeds, makes a mulch for the retention of the moisture of the muck beneath, prevents a too rank growth of the vine, to the detriment of fruit production, and makes the bog easier to work in wet weather. In Wisconsin this sand is drawn on the bog in winter when the bog is covered with water and frozen over. About every 4 or 5 years a further sanding ½ to 1 inch deep is required. Sometimes vines for planting are run through a hay cutter, sown by hand like wheat and rolled in. The vines should not be allowed to dry out or they will be worthless for planting. A well-cultivated cranberry bog will yield from 100 to 300 bushels per acre annually.

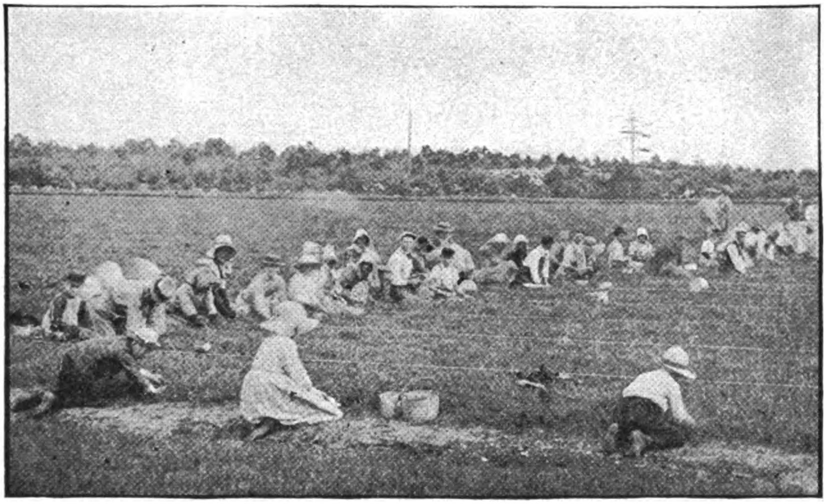


Fig. 246—HARVESTING CAPE COD CRANBERRIES

The crop is gathered by hand; various devices like hand-scoop rakes, etc., have been invented for facilitating this work. When frost threatens during the picking season the bog is flooded at night and the water drawn off in the morning. A scene of picking in a Cape Cod swamp is seen in Fig. 246.

Relative to cranberry culture, a Wisconsin writer states that if a bog has not a good water supply it is better to leave it in the natural state and take the crops which grow in favorable seasons than to spend money in improving it. For a further account of cranberry culture see "Cranberry Culture," by J. J. White, and "Cranberry Culture," by L. C. Corbett, in U. S. Dept. Agr. Farmers' Bul. 176.

Enemies: GALL FUNGUS (*Synchitrium vaccinii*) occurs on the leaves, stems, flowers and fruit. The galls are of a red color and infested plants may become red throughout, which renders a diseased bog conspicuous. The fungus attacks also huckleberry, laurel, azalea, etc. The galls appear early in May and cause a misshapen growth of the plants. The fungus is carried by the water of spring floods and perhaps by birds and winds. It may be partly controlled by withholding the water in winter and spring and by the burning of infected plants.

SCALD appears as 1 or sometimes several small soft spots on 1 side of the berry in July and August. Later the whole berry becomes soft and brown, and finally shrivels up. They may fall off or remain on the bushes in this condition. The leaves are also affected and the disease causes most damage in moist weather. Some advantage has been noted from sanding the bog. The ditches may be kept deep and the water low in midsummer.

The BLACK-HEADED WORM, also called vine worm or fireworm, and the yellow-headed worm are 2 species which feed upon the foliage. Paris green, London purple, kerosene emulsion, hellebore and pyrethrum have been used with good results in combating these pests. Flooding with water late in the spring is also beneficial.

The **Fruit Worm** feeds on the inside of the berries. It may be checked by spraying with Paris green just after the flowers fall. Cranberries are also occasionally attacked by grasshoppers and scale insects. For a further account of the insects affecting cranberries see U. S. Dept. Agr. Farmers' Bul. 178.

CURRANT (*Ribes* spp.)

Currants thrive best in the cooler Northern States and are easily cultivated. They succeed well in partial shade. In the more Southern localities and in some of the hot Western States shade is especially desirable. Varieties do not reproduce themselves true from seed and are therefore propagated by division of the plant. Where only a few plants are wanted they may be obtained by separating rooted canes from the mother plant, but in nursery culture new plants are propagated by layers or cuttings. The latter is the more usual way. Cuttings for this purpose are usually taken in the fall from the ripened wood of the season's growth. They are made about 8 inches long and may be set out in nursery rows at once or tied up in bundles and stored over winter. Where kept over winter the bundles should be stored in a pit in well-drained soil, with the butt ends up, and covered about 6 inches deep with earth. In the spring they may be set in the nursery rows as early as the ground can be worked. For this purpose the soil should be deeply plowed and trenches dug 8 inches deep. Against the perpendicular sides of these trenches the cuttings should be placed about 2 inches apart, with the top buds just above the surface of the ground, as shown in Fig. 247. Press the soil firmly about the butts of the cuttings and fill the trench up with earth, tramping it down firmly. Fall set cuttings are covered before winter comes on with a strawy mulch or manure and these removed upon the appearance of spring. Strong 1-year plants are the most desirable for setting out in the permanent plantation. The crop grows best in a rich, moist loam, but in small garden culture they will prove satisfactory on almost any soil. The currant rows should be about 6 feet apart, with the plants about 4 feet distant in the rows. It is the custom of many fruit growers to grow currants between the rows in orchards, and this is a very satisfactory method, since the growing trees furnish some shade to the currants and the ground is occupied with a money crop while the orchard trees are coming into bearing. Frequent shallow cultivation should be given the plants during the early part of the season.

With proper cultivation, pruning and fertilizing currant plantations remain in bearing many years. The currant naturally assumes a bushy form and requires but little pruning. From 4 to 8 canes should be maintained and these frequently renewed. All old canes should be removed when 3 or 4 years old and all straggling shoots shortened in. Clipping the free end of the currant cluster at flowering time resulted in increasing the size of the berries 7 per cent and the number 15 per cent at the New Jersey Agricultural Experiment Station. Plants sprayed with Bordeaux mixture after the fruit was picked at the Wisconsin Station held their foliage 4 to 6 weeks longer than those not sprayed.

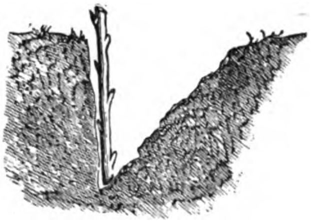


Fig. 247—MODE OF SETTING CURRANT CUTTINGS

Barnyard manure has proved the most satisfactory fertilizer for currants at a number of experiment stations and is recommended for this fruit. Put a few forkfuls around each bush in the fall in the form of a mulch. This should be forked into the soil later when it becomes thoroughly rotted. Instead of barnyard manure, one successful grower in New York used for full-bearing bushes 1000 pounds per acre of a mixture made up of 600 pounds of ground bone, 250 pounds of muriate of potash and 150 pounds of nitrate of soda. This should be scattered broadcast about the bushes and well worked into the soil in the spring. At the Massachusetts Experiment Station the effect of different commercial fertilizers on the composition of the fruit was studied. The highest colored fruit and the fruit containing the greatest amount of vegetable matter and mineral constituents was obtained from a plot (4200 square feet) fertilized with 45 pounds of dissolved bone-black, 18 pounds of nitrate of soda and 30 pounds of sulphate of magnesia. The addition of potash fertilizer to the plants in these experiments was invariably accompanied by an increase in the potash content of the fruit, varying from 6 to 11 per cent, and was accompanied by a corresponding decrease in phosphoric acid and lime. On the whole, it is thought that potash fertilizers decidedly improved the quality of the fruit.

Botany and Varieties—The commonly cultivated red and white currants of our gardens belong to the species *Ribes rubrum* and the black currants to *R. nigrum*. The black currant is little grown in this country, though popular in Canada. It is used largely for jelly. One of the best known varieties is Black Naples. A native wild currant (*R. aureum*) of the Western prairies, known as Missouri currant, Buffalo currant, etc., is sometimes grown in gardens. One of the best improved varieties of this sort is the Crandall. It is hardy and has been found useful for pies and jelly, but has little to recommend it in Eastern sections. The varieties of currants most popular at the experiment stations are as follows: *Red*—Cherry, Fay, Versailles and Red Dutch; *White*—White Grape (Fig. 248), White Imperial and White Dutch. (See also N. Y. State Expt. Sta. Bul. 95.)

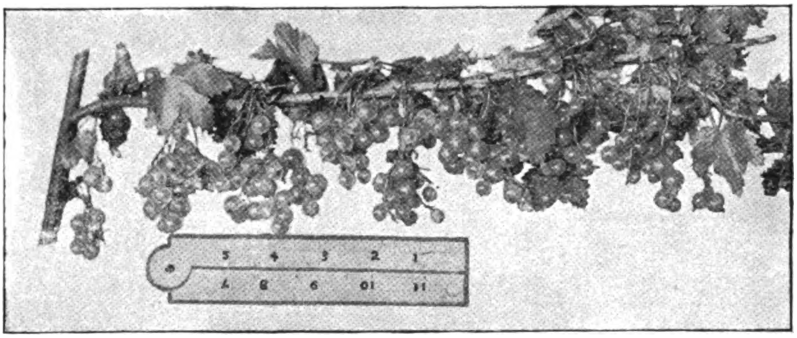


Fig. 248—WHITE GRAPE CURRANT
(From Wyo. Expt. Sta. Bul. 34)

Enemies: Leaf Spot (*Septoria ribis* and *Cercospora angulata*) attacks all varieties of currants and gooseberries. It appears at midsummer as small brown spots on the leaves. Experiments at the Iowa Station showed that 5 applications of Bordeaux mixture will completely check the disease. A clear fungicide like ammoniacal solution of copper carbonate may be used during the berry season. The effect of punctures by leaf bugs sometimes resembles leaf spot.

Cane Blight appears as a sudden wilting, death and drying of the canes. It begins in May and continues through the season. The fungus spreads in both directions from the point of infection. Diseased canes should be cut out and burned. In order to prevent spreading the disease in pruning, the knife should be occasionally dipped in a disinfectant solution.

Knot (*Nectria cinnabarina*) is first noted by a wilting, discoloration and drying of the foliage. Fruit clusters on affected plants are small and the berries are prematurely colored and fall off with the leaves. Small warts of a red color develop on diseased canes in the fall. Usually the canes are killed and sometimes the roots. The fungus may live for some time in canes before the symptoms of disease appear. Cuttings should therefore be taken only from plants which are known to be healthy. Diseased plants should be removed and destroyed.

Anthracnose (*Gloeosporium ribis*) appears in June or July as small brown or black spots, chiefly on the upper surface of the leaves, which soon turn yellow and fall away. The fungus probably passes the winter in fallen diseased leaves. Such material should be burned. Spraying with standard fungicides like Bordeaux mixture will help to check the disease. (See *Spraying*.)

Powdery Mildew—See under *Gooseberry*.

Borer (*Sesia tipuliformis*) is a dark blue moth with yellow bands across the body and a yellow collar. The caterpillar is white, with a brown head. The moth lays her eggs in May near buds on the outer branches. After hatching the larva bores to the center of the stem and stays in the pith until the following year, when it emerges as a moth. Affected canes are easily recognized and should be cut out and burned.

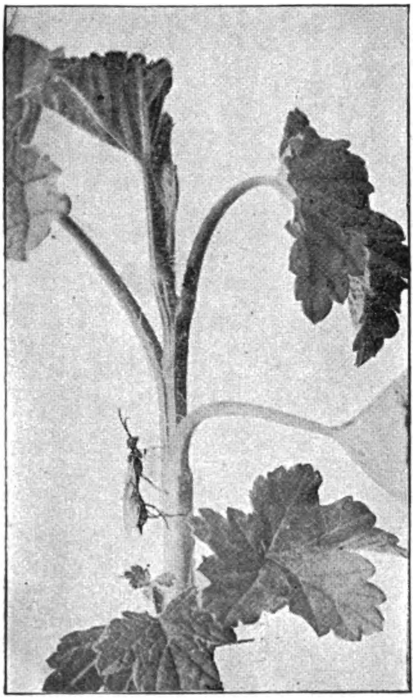


Fig. 249—CURRANT STEM GIRDLER
(From N. Y. Cornell Expt. Sta. Bul. 126)

Fly (*Epochra Canadensis*) is nearly as large as the common housefly, but more slender, with longer wings. The body and legs are yellow and brown. The flies are often seen around currant or gooseberry bushes. They deposit their eggs in the berries, and the larvae when full grown leave the berries before or after they have fallen to the ground and conceal themselves in the soil. Infested fruit should be gathered and destroyed. The pupae of the fly may be killed by deep spading in the winter. Mulching and allowing chickens to run among currant bushes has been recommended.

Sawfly (*Nematus ribesii*) is a 4-winged fly of a yellow color. The females deposit their eggs on the lower side of the leaves in rows along the vein. The young hatch out in a few days and feed on the leaves. This pest may be easily destroyed by spraying with arsenical poisons when the leaves are newly developed, or with hellebore either dry or mixed with water after the fruit is set.

Span Worm (*Eufitchia ribearia*) is a caterpillar more than an inch long, of a whitish color, with a yellow stripe down the back. The caterpillars let themselves down by means of a silk thread when disturbed. This habit makes it possible to jar the bushes and collect the caterpillars which have fallen and crush them.

Stem Girdler (*Janus flaviventris*) is a sawfly, with shining black body and yellow legs. (Fig. 249.) The flies appear in May and girdle the shoots by cutting slits in them. The eggs are deposited just below the point where the stem is girdled. Sometimes the tip above this point falls off, but usually it remains in connection with the stem for some time. Infested stems should be cut out and burned.

Four-Lined Leaf Bug (*Poecilocapsus lineatus*) is 1-3 of an inch long, yellow above, with 4 black stripes. The eggs are deposited near the tips of the young shoots and hatch during the following spring. The adult is found during June and July attacking the leaves and tips of shoots, and sucking out the juices. Small brown angular spots are produced on the leaves by the action of this insect. During the cool part of the day it may be jarred from the bushes and caught in vessels containing kerosene. In cases where large numbers of eggs are observed on the tips of shoots such parts should be cut away and burned.

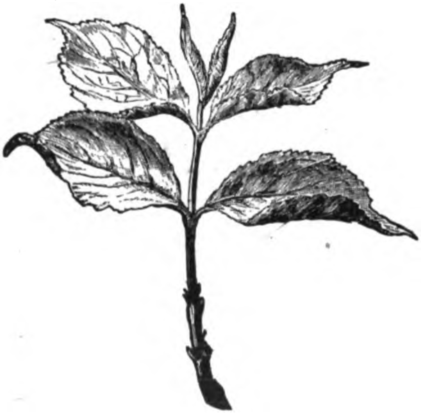


Fig. 250—GREEN WOOD CUTTING

CUTTINGS

These are parts of plants used in the place of seed for producing new plants. Under proper conditions they may be set in soil or water, where they take root and produce new stems. Many improved varieties of fruits, nuts, etc., do not come true to name when grown from seed, but instead produce fruit of very inferior quality. This difficulty is obviated in some cases by the use of cuttings. Plants grown from cuttings possess the same characteristics as the parent from which they were taken. According to the part of the plant from which such cuttings are taken they may be designated as stem cuttings, root cuttings, leaf cuttings and tuber cuttings. Cuttings may also be classified according to the kind of wood from which they are taken, as dormant, semi-dormant, etc. Improved varieties of grapes, currants and gooseberries are usually propagated from stem cuttings taken in the late fall or winter when the wood is dormant; blackberries and raspberries from root cuttings; potatoes from tuber cuttings, and many greenhouse plants from leaf cuttings. The proper method of making and handling cuttings varies with the particular plant propagated and will therefore be considered in connection with the different plants. A green wood cutting is seen in Fig. 250.

DATE PALM (*Phoenix dactylifera*)

A few dates have been grown for a number of years in some portions of California and Arizona, but it is only recently that the possibilities of the Southwest have been investigated with reference to the commercial production of dates. The United States Department of Agriculture and the New Mexico, Arizona and California Experiment Stations have been most active in this work. The indications are that some portions of the Southwest—more particularly the Colorado Desert and some parts of Ari-

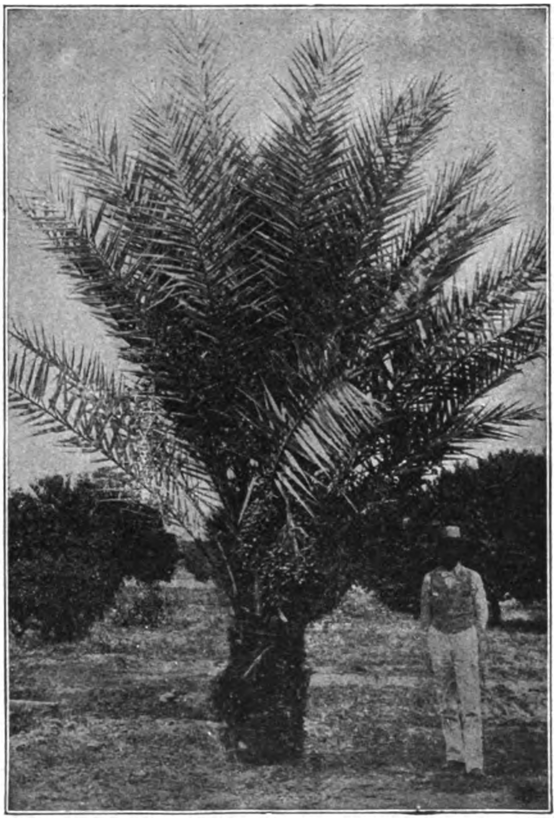


Fig. 251—DATE PALM
(From Yearbook U. S. Dept. Agr. 1900)

zona, California, New Mexico, Texas and Nevada—are favorably situated for date growing.

Dates require for successful fruit production an average summer temperature from May to October of 70° to 80° F., and luxuriate in temperatures of 110° to 125° F. When dormant in winter it is hardier than the orange and will withstand 12° to 16° below freezing. The climate must be dry. In moister regions the palms will grow, but produce no fruit. Water is indispensable. The roots must be kept moist at all times and an abundant supply of irrigation water must be provided.

The date palm is especially suited for culture in desert regions where climatic conditions are favorable. It is able to withstand without injury large quantities of alkali in the soil and irrigation water. This is one of its most valuable features. Trees true to name are grown from suckers. They are planted 25 to 30 feet apart each way. The male and female flowers are borne on separate plants. About 1 male is required to pollinate every 25 females. At the blooming time of the female flowers clusters of male flowers are tied among them to insure pollination and a full set of good fruit. Trees may begin to bear within 4 years after being set out, but paying quantities are not secured until the trees are 6 or 8 years old, and full crops are not obtained until 10 or 11 years after planting. A full bearing tree produces 100 to 200 pounds of fruit per year, though sometimes 300 to 600 pounds are obtained. At the Arizona Station a tree 8 years old produced 400 pounds. (Fig. 251.) Large importations of the best varieties of date palms grown in the Sahara regions have recently been made and planted in the most promising regions of the Southwest, and at this writing it would appear that the production of dates is destined to become one of the important industries of that region. For further notes on the culture of dates see Ariz. Expt. Sta. Bul. 29, and U. S. Dept. Agr. Yearbook for 1900.

DEWBERRY (*Rubus* spp.)

This is a trailing form of the blackberry that has but lately come into cultivation. The dewberry grows wild all over the country and the fruit is indistinguishable by the general public from that of the blackberry. It is of large size, attractive in appearance, and from 10 days to 2 weeks earlier than the standard varieties of blackberries. Ripening as it does between raspberries and blackberries, there is usually a profitable demand for the fruit. As yet, however, only a comparatively few fruit growers have undertaken its cultivation. The plant is not a sure cropper. Often the flowers fail to set, many nubbins rather than full-sized berries being formed. The trailing habit of the vines and the multitude of thorns on some varieties make picking laborious. Notwithstanding these drawbacks, it is believed there is a future for this fruit.

Soils and Culture—The dewberry is found wild on the lighter, poorer soils of the country. In cultivation it succeeds best on well-drained, sandy loams, though success has been reported on nearly all soils. Some varieties, like Windom and West, delight in partial shade, and a cool northern exposure is often recommended for this crop. The fertilizers required are about the same as for the blackberry, *i. e.,* wood ashes and barnyard manure.

Dewberries are generally propagated from tips like blackberries, though sometimes from root cuttings. The tips are rooted by covering with soil about the time the shoots have completed their growth. The plants are set in rows 4 to 6 feet apart and 3 to 4 feet distant in the row, depending on the method of training adopted. The New York Cornell Station prefers training the plants to stakes 4 feet apart each way. Four to 6 canes are allowed to grow from each plant, and these are tied to the stakes with wool twine or willow thongs 2 or 3 times during the season as they grow. Where a flat 3 or 4-wire trellis is used the space between the rows should be 5 or 6 feet. The frequent failure of dewberries to set fruit is believed to be due to the lack of proper pollination, and it is quite generally believed that this can be overcome in a measure by planting different varieties together.

The fruit of the dewberry, like that of the blackberry, is borne on year-old canes. After these have fruited they should be cut out and the new canes which have been growing at the base of the plant tied up to the trellis. It is usual to leave these canes lying on the ground during the winter, especially in cold localities, for protection. Scarcely any pruning will be required, except a shortening in of the longer canes as they are tied to the trellis or post. Only 4 or 5 canes should be left in each hill. If the canes are not trained to posts a trellis, such as is employed with grapes, may be used, or a flat trellis made of wire placed 10 or 12 inches from the ground and a foot or more in width. With some growers the canes are not tied up at all, but allowed to trail on the ground, a mulch of straw being placed underneath to keep the fruit out of the dirt. The best fruit cannot be produced in this way, but any method of training that will keep the fruit off the ground will generally be found satisfactory.

A very convenient form of trellis is that used at the Georgia Station. The wires are 2 feet from the ground and 22 inches apart. At this station a dozen or more canes are left to grow in each hill. As they become long enough they are brought up between the wires of the trellis and left to trail down over either side, the ends being clipped off so that they do not trail on the ground. "This may not be the most scientific method of treatment, but it is certainly for this region the most economical and practical."

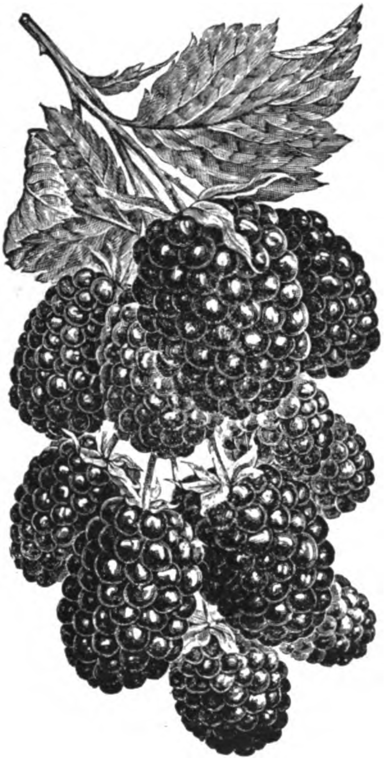


Fig. 252—LUCRETIA DEWBERRY

A plantation of dewberries will endure for a good many years. Often the vines do not come into their best bearing until the plantation is 3 or 4 years old. The yield of fruit is extremely variable. The Cornell Station places the yield of the variety Lucretia, when grown from 2 to 3 feet apart in 3½-foot rows, at 50 to 60 bushels per acre. Vines in the North should be laid down upon the approach of winter and covered with a few shovelfuls of earth for protection.

Varieties—There are about 20 named varieties of dewberries in cultivation. The Lucretia (Fig. 252) is probably the best known and most widely grown variety. It is especially recommended for New York and the Northern States generally. The Windom is considered very promising for the central Northwest. It is a native of Minnesota. Bartel or Mammoth has found much favor with fruit growers in Wisconsin and Nebraska, but has not as yet proved very satisfactory in the East. Manatee is one of the best Southern varieties and is a native of Florida. Austin Improved is the only variety deemed worthy of cultivation at the Georgia Station. On the Pacific coast the Loganberry is widely grown. (See *Loganberry.*)

Botany—The botanical types to which the cultivated dewberries belong are stated by the New York Cornell Station as follows: "(1) The Northern dewberry, or *Rubus Canadensis* [now *R. villosus*]. To this type belong the Windom, Lucretia's Sister, and Geer. (*a*) The Lucretia sub-type, or variety *roribaccus*, comprising the Lucretia. (*b*) The Bartel sub-type, or variety *invisus*. To this belong Bartel or Mammoth, General Grant and Never Fail. (2) Southern dewberry, or *Rubus trivialis*. Here belong Manatee, Bauer, Wilson White and Austin, and probably Fairfax. (3) The Western dewberry, or *Rubus vitifolius* (known also as *R. ursinus*). Here belong the varieties known as Aughinbaugh (one of the reputed parents of the Loganberry), Skagit Chief, Belle of Washington and Washington Climbing. None of these berries have been well tested beyond the Pacific Coast region." (See also N. Y. Cornell Expt. Sta. Buls. 34 and 117; Ga. Expt. Sta. Bul. 33.)

For enemies see *Blackberry.*

FIG (*Ficus carica*)

The fig is extensively grown in California and the Southern States. North of the Carolinas some kind of winter protection, such as covering with pine boughs or earth, is necessary. With some winter protection figs are grown as far north as Maryland. Figs are eaten in the fresh state as a dessert, but the taste for them is an acquired one. Fresh figs are seldom ever seen in the Northern markets, since they ripen at a time when other fruits are plentiful, are uninviting in appearance, do not stand shipping well, and most people do not like them until they have learned to. Canned figs are in constant request and the supply seldom ever equals the demand. It is in the dried condition, however, that figs are most widely known. California is practically the only State producing dried figs in commercial quantities in this country. Fig. 253 shows a fig twig in bearing.

Soil—The best soil for figs is warm, moist, well-drained loam, well supplied with lime, potash and phosphoric acid. In California the experiment stations have found that the fig is strongly resistant to alkali, being nearly equal to the date palm in that respect.

Propagation—The fig is usually propagated from hard wood cuttings of the previous season's growth. These may be of almost any length, but will grow from single eye cuttings. The cuttings are made and handled like grape cuttings. In California cuttings are set in the nursery in December or January and should be long enough so that the lower part will be in moist soil constantly. The upper bud should be just at the surface of the soil. Cuttings will be ready for the nursery within a year. In the Southern and Eastern States cuttings may be set out in the open in April or May, or started earlier with bottom heat.

Fig trees in California grow to a very large size, some old trees having trunks 2 feet in diameter. In the orchard the smaller growing varieties are usually set 25 feet apart each way and the larger ones 40 feet. In the East the trees are largely grown close together as shrubs. No pruning further than the removal of dead branches and sufficient to keep the tree open to light and air is necessary. Shallow cultivation is practiced in the orchard, and while the trees are small some intercultural crop is grown.

In the Southern States the most prominent varieties grown are Celestial, Brown Turkey and Adriatic; and in California, White Adriatic, Black California, White Marseilles and, within the last year or so, the Smyrna fig. The successful culture of this latter fig is of so peculiar a nature and of so much importance that it requires special mention.

Smyrna Fig—The Smyrna fig is the commercial fig of the countries lying east of the Mediterranean Sea, and is the dried fig of commerce in this country, a box of which ready for market is seen in Fig. 254. It is propagated and cultivated like the common figs mentioned above, but the fruit does not set unless fertilized with pollen from wild fig trees, or Capri figs, as they are called. The Capri fig is of no value whatever as a table fruit, but within it develops the fig wasp (*Blastophaga*), the female of which carries the pollen from the wild flowers to the flowers of the Smyrna fig, thus cross fertilizing them and making the development of fruit and seed possible. Each Capri fig contains an enormous number of wasps. At the proper season from 15 to 30 of these figs are hung in the branches of each Smyrna tree. As the female wasps come out of the figs to find other blossoms in which to lay their eggs they are covered with pollen. In their endeavor to find Capri fig blossoms many enter the Smyrna figs. The eye of the Smyrna fig is very small, and the wasps, in getting into the blossom, lose their wings. They crawl clumsily about inside the fig blossom to find a place to deposit their eggs, and in doing so the pollen from their bodies is brushed off on the pistils of the Smyrna blossoms, thus fertilizing them. The wasp dies inside the fig and is absorbed by it, as are also the eggs she may lay.

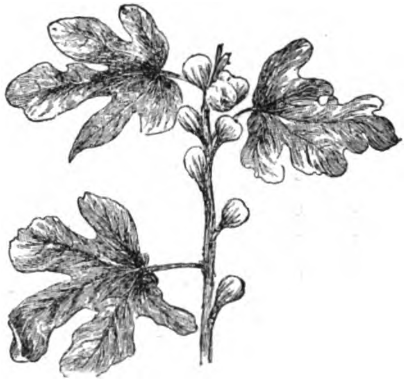


Fig. 253—FRUIT AND FOLIAGE OF FIG

The Capri fig tree is absolutely essential for the perpetuation of the wasp, and it requires about 2 Capri fig trees to every 100 Smyrna trees. The successful introduction of the fig wasp in this country was accomplished by the United States Department of Agriculture in 1899. Previous to that period only a few Smyrna figs were grown, and these by means of hand pollination. During the last few years tons of Smyrna figs, rivaling in quality the best Smyrna figs of the old world, have been grown. The complete account of the new industry thus successfully established in America by the introduction of this minute insect forms one of the most interesting chapters in the history of fruit culture in this country. Fig trees of ordinary varieties can be easily grafted over with Smyrna or other improved varieties. The limbs should be cut back to within 18 to 24 inches of the trunk, allowing at least 2 to remain intact on the south side of the tree to afford shade for the cions until the following year. From 2 to 4 cions 5-16 to ½ inch in diameter, and preferably from 2-year-old wood, should be inserted on each stock. A V-shaped piece of bark 1 to 1¼ inches long should be removed from the stock and the cion cut to fit snugly into the V. It should be tied firmly in place by 5 or 6-ply cotton twine and the wound, stub and top of the cion well covered with liquid grafting wax. After the cions have united the strings should be cut. An exhaustive account of fig culture may be found in U. S. Dept. Agr. Div. Pomology Bul. 9.

Enemies—Fig leaves are often attacked by yellow and red rusts. Diseased spots fall out, leaving holes in the leaves. Spraying with Bordeaux mixture is the best remedy.

The FIG BEETLE (*Allorhina nitida*) is about 1 inch in length and of a green bronze color. It appears when the fruit begins to ripen and attacks the fruit, sucking out the juices. The beetle may be jarred into vessels containing kerosene. The jarring should be done in early morning while it is cool.

When adult June beetles are present in large numbers they may be destroyed as recommended for the fig beetle.

GOOSEBERRY (*Ribes* spp.)

This is one of our hardiest fruits, and since methods have been found to control the mildew which often seriously affects it, the crop is one of the surest and easiest to grow. The best soil for gooseberries is a rich, rather heavy clay loam, well drained. In garden culture they will do fairly well on almost any soil.

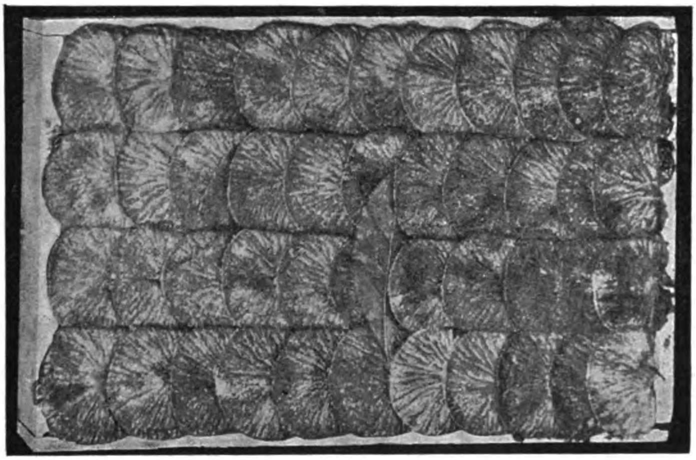


Fig. 254—A BOX OF DRIED SMYRNA FIGS
(From U. S. Dept. Agr. Div. Pom. Bul. 9)

Propagation and Culture—Gooseberries are generally propagated by suckers and mound layering, though the American varieties grow easily from 8-inch cuttings of new wood fairly well matured taken in October. In small garden practice rooted canes may be separated from old plants and set out. These grow readily. Nurserymen generally propagate by mound layering. In this process old plants, called "stools," are well headed back. Many new shoots are soon sent up in the spring, and when these become fairly well hardened along the last of June and first of July they are crowded outward and the center of the stool covered with earth to about 4 inches above the base of the shoots and well packed down. In the fall or the spring following the rooted shoots are removed from the mother plant and transplanted to the permanent plantation. There they should stand about 5 feet apart each way to permit of cultivation in both directions, or 3 to 4 feet apart in rows 5 to 6 feet apart. Gooseberries are sometimes set between the rows in orchards. In such cases they should not be planted nearer the trees than 6 feet. In setting out plants all broken or bruised roots should be cut off smoothly and the tops shortened to correspond with the amount of roots.

Gooseberries may be trained to a low tree form with a single main stem, but the more usual method is to train to a bush form. In the former method all the eyes or buds on the cutting or layer are removed on that portion of the stem below ground, while by the latter method they are left on and thus produce many suckers for renewing the older canes later on. But little pruning other than a short clipping back of the shoots is required for the first 2 or 3 years. The object of the clipping is to develop fruit spurs along the cane. Further pruning consists in the removal of weak or broken branches and old canes that have passed their most fruitful period, and the keeping of the bushes in the best form for cultivating, gathering of fruit, spraying, etc. Well-rotted stable manure is one of the best fertilizers. The plants require no winter protection. They need shallow cultivation throughout the growing season.

Gooseberry fruit is marketed both green and ripe. The green fruit is the more easily picked. The vines are rapidly stripped and the fruit run through a fanning mill to free it from leaves, sticks, etc., after which it is packed in baskets for market. The reasons advanced in favor of marketing gooseberries unripe are stated by S. A. Beach in N. Y. State Expt. Sta. Bul. 114, as follows:

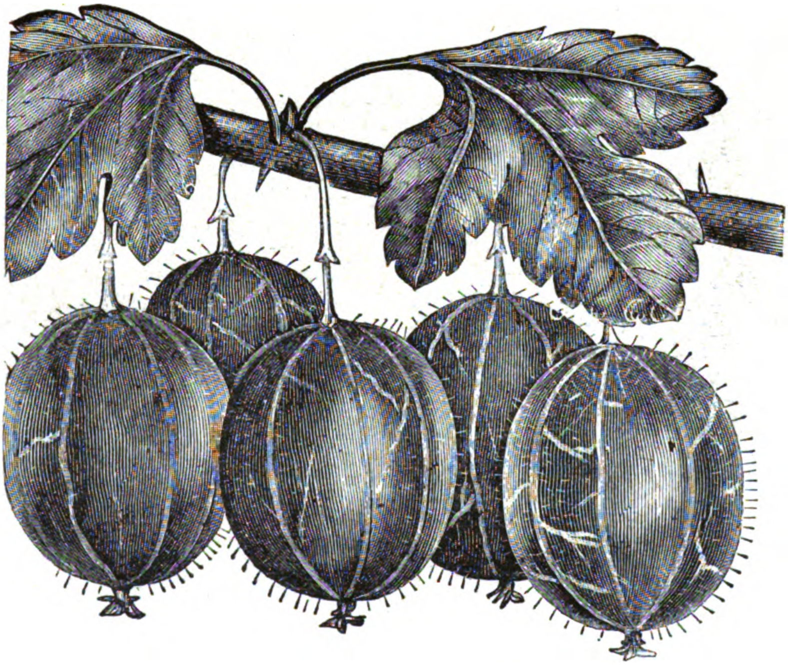


Fig. 255—INDUSTRY GOOSEBERRY

"(1) The hard green fruit is not as easily injured in picking and packing as the pulpy ripe fruit is, and it will stand transportation better. (2) The fruit that is allowed to ripen on the bushes is exposed longer to attacks of sunscald and mildew, and, should long continued rain follow a period of drouth, the ripening fruit is liable to crack and spoil. (3) The ripening of the fruit and seed is an exhaustive process, from which the bush is partly relieved when the fruit is marketed green. (4) The proceeds from the green fruit usually compare favorably with the proceeds from the ripe fruit, although the large ripe English varieties sometimes bring the highest prices of the season."

Botany and Varieties—Two classes of gooseberries are grown in this country, the European (*R. grossularia*) and American (*R. oxyacanthoides* and *R. cynosbati*). Relative to the merits of these 2 classes the New York State Station states as follows: The European class shows superiority in the large size and the variety of colors of the fruit and in the early marketable condition of the green crop. The European varieties are also preferred at fruit-preserving establishments. The best of the American varieties are superior to the European gooseberries as a class in productiveness, hardiness, ease with which they may be propagated, quality, delicacy of flavor and thin texture of the skin of the fruit, and freedom from mildew.

Of the European varieties, Industry (Fig. 255) is considered one of the best, being a strong grower and very productive. Crown Bob is an excellent variety for early market. Lancashire Lad is a vigorous variety, suffering but little from mildew. Other good varieties are Wellington Glory, Dominion and Triumph. Of the American varieties Downing stands at the head in productiveness and is rarely troubled with mildew. Other good varieties are Houghton, Pale Red and Crystal. The latter variety averaged 13⅛ pounds per bush at the New York State Station for 4 years.

Enemies: Leaf Spot—See under *Currant.*

Powdery Mildew (*Sphaerotheca morsuvae*) first appears on the young half-grown leaves and terminal buds. Affected parts are covered with a white powdery substance. The berries are attacked in the same manner, usually on one side, and become irregular in shape. Experiments with formalin, lysol, Bordeaux mixture and potassium sulphide indicate that potassium sulphide is the most effective fungicide for this disease. It should be used in the proportion of 1 ounce to 2 or 3 gallons of water. Spraying should begin just as the buds are unfolding and should be repeated at intervals of about 10 days. A branch affected by gooseberry mildew is seen in Fig. 256.

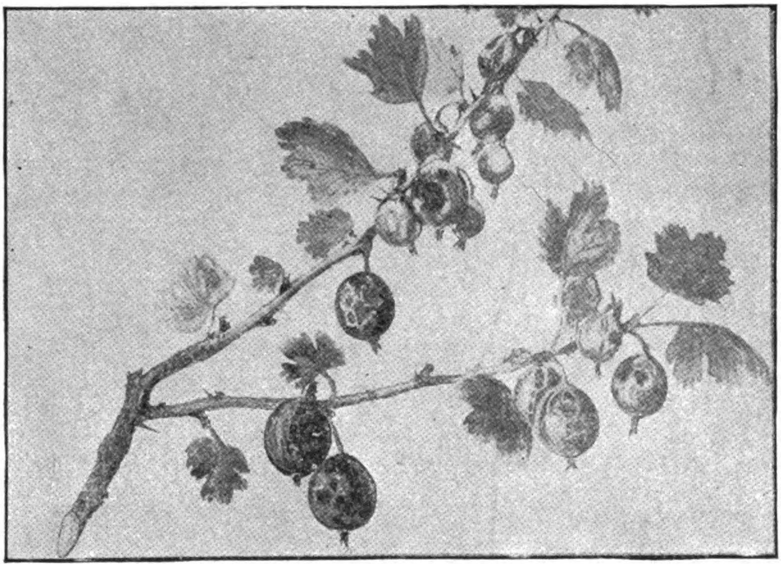


Fig. 256—GOOSEBERRY MILDEW
(From N. Y. State Expt. Sta. Bul. 161)

Rust (*Aecidium grossulariae*) appears as bright yellow swollen spots on the leaves of gooseberry and cultivated currants in spring or early summer. It is usually not very harmful and may be controlled by picking and burning affected leaves.

Fruit Worm (*Dakruma convolutella*) is the larva of a gray moth which lays its eggs on gooseberries in early spring. The pale green larvae feed within the berries and cause them to turn red and fall prematurely. When one berry is destroyed the larva enters another, fastening the berries together by silken threads. Infested berries should be picked off and destroyed. Bushes should be dusted with air-slaked lime in April and May, when the eggs are laid.

For other insect pests see under *Currant.*

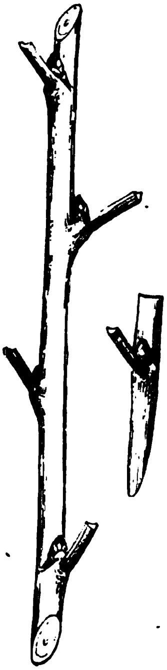


Fig. 257—BUD STICK WITH BUD PREPARED FOR INSERTION

GRAFTING

This is the process of inserting a piece of plant, usually a bud or twig, in another so that it will grow. Grafting is employed to propagate varieties of fruit, nuts, etc., that do not come true from seed; to change over orchards, already established, into more desirable sorts; to dwarf plants; to grow tender sorts on hardy roots or in adverse soils, etc. It is a necessary practice with nearly all orchard fruits, most nuts, the European varieties of grapes grown in most places in this country, and with many ornamental shrubs, etc. The plant on which the grafting is done is termed the stock, and the part inserted into the stock is called the cion, though by cion is usually understood a twig consisting of 1 or .more buds rather than detached buds. The essential principle in grafting is to bring the cambium layer (growing tissue between the bark and wood) of the cion and stock in close contact with each other and to keep them there until they grow together. There are innumerable methods of grafting, but these may be classified as (1) budding, (2) cion grafting, and (3) grafting by approach.

Budding—Budding is practiced with peaches, cherries, plums and most stone fruits, and in Eastern nurseries apples and pears are largely budded. It consists in inserting a single bud under the bark of the stock. It is practiced more especially with small stocks 1 or 2 years old. Older trees are cion grafted or the larger limbs are cut back and the sprouts allowed to grow for a year and these then budded. Budding is usually performed in July, August or September, when the bark of the stock is loose and will peel. It may also be done in the spring. One-year-old nursery trees are budded 2 to 3 inches above the ground, and preferably on the north side of the stock. If budded in the spring the buds are taken from twigs of the previous season's growth, and if fall-budded from the growing twigs of the season. A T like cut is made through the bark of the stock, as seen in Fig. 258, the bark is then slightly lifted near the top of the cut and a little piece of bark containing the bud, as shown in Fig. 257, is inserted and pressed down so that it is held firmly in place. The bud is then tied firmly in place, as shown in Fig. 258, with raffia, a cheap commercial tying material, or some soft yarn. No wax or other covering material is used.

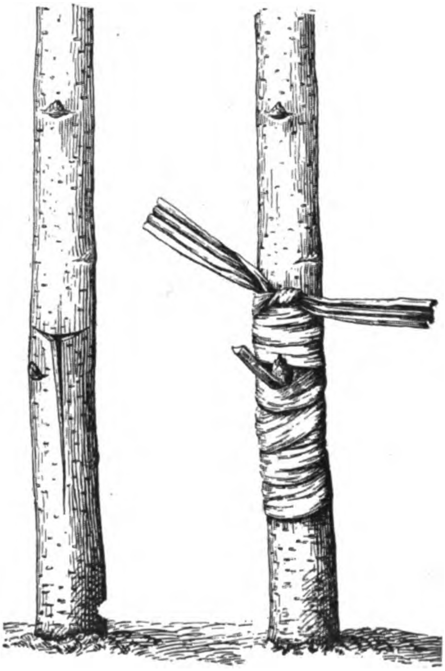


Fig. 258—THE BUD INSERTED AND SECURED

The stock is prepared for budding by stripping away the lower leaves and twigs from the area to be budded. The bud should be cut from the twig with a sharp thin-bladed knife. Only the bark is required, but just underneath the bud the operator should cut a little into the wood. Small buds will be found in the axils of the leaves. These leaves should be removed at once, leaving only a small part of the stem as a handle. Special care is required that the buds do not dry out. They should be left on the twig or bud stick, as it is called, until wanted for use. The bud usually "takes" in 2 or 3 weeks, after which, in the case of fall-budded trees, the stock above the inserted bud should be cut away entirely about an inch above the insertion and all other buds removed.

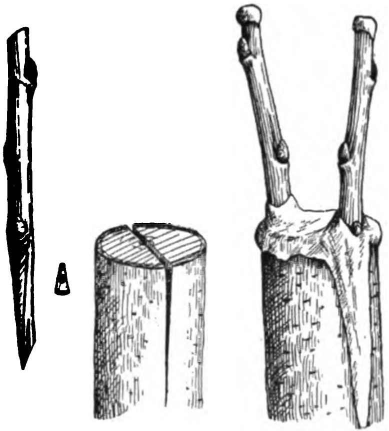


Fig. 259—CLEFT GRAFTING

Cion Grafting—There are an infinite number of ways of uniting cion and stock in cion grafting, but the more common are the cleft graft and the whip or tongue graft. Cleft grafting is practiced with rather large branches and is done early in the spring. The cions are taken from the shoots of the previous year's growth, and generally consist of 3 buds. They are made some time previous, tied in bundles, labeled, and kept stored in some cool place to keep them perfectly dormant. The illustration (Fig. 259) shows the method of cutting the cion, inserting it in the stock and covering the wound over with grafting wax. The wedge-shaped part of the cion should be a little thicker on the outside so that the pressure of the cleft will hold the cambium layers of stock and cion in close contact. Two cions are usually set in each stock, with the lower bud of the cion near the top of the wedge. This bud, though usually covered with grafting wax, is the one that most frequently grows, since it is nearest the supply of food material furnished by the stock. Should both cions grow 1 may be removed later if it is found desirable.

The wax used for covering over the wound is made by melting together beeswax, tallow and resin. A very good formula for outdoor use is made of 1 pound tallow, 2 pounds beeswax and 4 pounds of resin. The melted mixture should be poured in a pail of water and pulled with greased hands until it becomes light colored and grains. It may then be put away in oiled paper and will keep indefinitely. The warmth of the hands will be sufficient to soften it for use in the orchard. The hands must be greased to prevent it from sticking to them. The wounds should be covered air tight with the wax.

Whip or tongue grafting is commonly employed in grafting seedling apple roots with improved varieties and with other small stocks. The cion and stock in whip grafting should be approximately the same size. The illustration (Fig. 260) shows the different steps in this process. In root whip grafting the parts are held firmly in place by a few wraps of cotton yarn drawn through melted wax and wound up on a spool. In root grafting with apples, thrifty 1-year-old stock is taken up in the fall and stored in a cellar where it will keep moist. Some time during the winter these roots may be cut in 2 or 3 pieces and each piece grafted with a cion. These root grafts are then tied in bundles and packed in

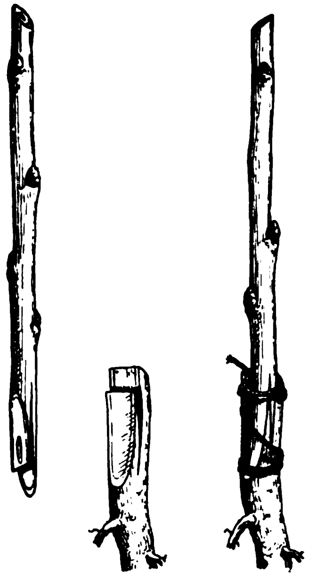


Fig. 260—TONGUE OR WHIP GRAFTING

moist earth until spring, when they are set in the nursery row. A method of side grafting shown in Fig. 261 is frequently employed in greenhouse work.

Grafting by Approach—In grafting by approach or inarching 2 branches are brought together and united without detaching either branch from the parent plant. This is accomplished by making suitable wounds in the branches and bringing them together so that the cambium layer of one will come into intimate contact with the cambium layer of the other. The branches are then bound together at the point of contact and waxed. When the cion has united with the stock it is cut off below the union and the top of the stock removed. This method of grafting is but little used.

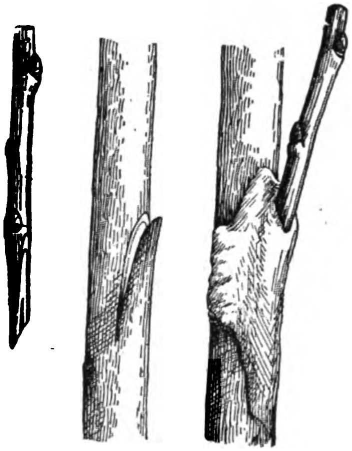


Fig. 261—SIDE GRAFTING

The peculiarities of grafting or budding will be noted under the plants affected.

GRAPES (*Vitis* spp.)

This fruit is successfully grown over practically the whole country and is the surest to bear each year of all our fruits. Vines commence to bear after the third year from planting in the vineyard, and the plantation, with reasonable attention, lasts more than a lifetime. Grapes are easy to grow and do well on almost any drained soil well cultivated. On gravelly loam containing a good proportion of clay they perhaps do best, but the best grape district of Michigan is located on sandy loams, where wheat will not average 15 bushels per acre. The fruit revels in sunshine, and hence vines should have a warm exposure toward the sun.

Propagation—Grapes are propagated by seed, layers and cuttings, also by grafting. Varieties do not come true to name when grown from seed, but do when grown from layers or cuttings. Grapes may be layered either in the early spring or late summer. The spring is preferred. A cane of last season's growth is laid in a trench 2 to 3 inches deep and pinned down to the ground. When the shoots from this cane have grown 6 to 12 inches the trench should be filled with good fine soil and well tamped down. Thus treated the canes make both shoots and roots at each of the joints. The following spring these may be separated from each other and planted in the permanent vineyard. This is the surest way of growing grapes, but is not so simple as growing from cuttings.

Grape cuttings should be made after the leaves drop in the early fall from well-matured wood of the present season's growth. Each cutting should have at least 2 joints, as shown in Fig. 262. The cut at the lower end should be made just below a joint, and at the upper end an inch or two above a joint. The cuttings thus prepared should be tied in bundles and buried in well-drained soil over winter. In the spring the cuttings should be planted about 2 inches apart in loose rich soil and at a slight angle. The planting is most easily done by thrusting a spade in the soil at an angle of about 30° and pressing the soil forward. The cuttings are then inserted so that the tops are about level with the soil surface. The spade is then withdrawn and the soil pressed firmly with the heel about the lower ends of the cuttings. The rows of cuttings should be about 4 feet apart. During the summer they should make a growth of 2 to 8 feet in length and be ready for transplanting to the permanent vineyard either in the fall or the following spring. This is the usual method of propagating such varieties as Concord, Niagara and most of the varieties of grapes grown in the eastern part of the United States.

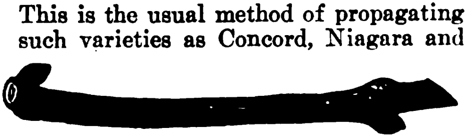


Fig. 262—GRAPE CUTTING

Planting—One or 2-year-old vines may be used. At planting time the tops should be cut back to 3 or 4 eyes and the roots well shortened in. Large holes should be dug so that the roots may be about 6 inches below the soil surface and well spread out. Fine soil should then be worked around them and well firmed down with the feet. The vines should be set 6 to 8 feet apart in rows 8 feet apart.

Pruning—The first season let the vines grow at will. The following spring prune back the strongest cane to 3 or 4 eyes and remove the others. After the buds start in the spring leave the 2 strongest shoots to grow and rub off the others. These 2 shoots should be trained to a stake or spread horizontally on a trellis and left to grow during the summer. They are the canes which are to form the permanent arms of the vine. They will bear the upright shoots from which the fruit of succeeding years is to be obtained. From now on the principle to be remembered in pruning grapes is that the fruit never grows on last year's wood, but always on the new wood of the present season's growth, which springs from wood grown the preceding season. The fruit is borne near the base of the shoots. Each shoot should bear only 2 to 6 clusters, but only a limited number of clusters—from 30 to 80—should be allowed to develop on 1 vine. The pruning is done any time from December to March. If a vine is strong enough to bear 30 clusters of grapes about 15 buds should be left at pruning time, and if strong enough to bear 80 clusters 40 buds should be left.

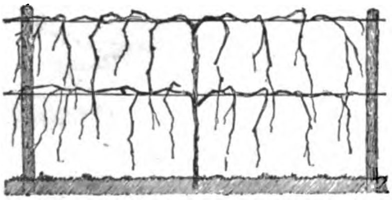


Fig. 263—THE KNIFFIN SYSTEM OF GRAPE TRAINING

With these principles in mind it will be seen that the essential operation in pruning grapes is to cut back a limited number of the best canes to a few buds each season and entirely remove the others. The more usual method at the present time is to cut the canes back to 8 to 10 buds and to leave but 3 or 4 canes, all of which should start from near the head or trunk of the vine. New arms should be taken out from year to year as the bearing wood gets farther away from the trunk.

Training—There are many methods of training grapes; the more usual is to train on a trellis made of 2 or 3 wires (Fig. 263), the top wire being about 5 feet from the ground, the bottom wire 2 feet or a little more, and a third wire intermediate between these. The 2 arms of the vine may be tied to the lower wire and the shoots trained to the upper ones, or the arms trained to the upper wire and the downward-growing shoots fastened to the lower wires.

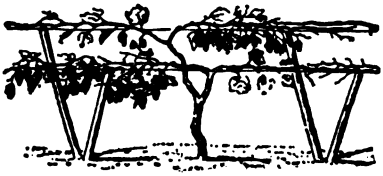


Fig. 264—THE MUNSON SYSTEM OF GRAPE TRAINING, SIDE VIEW

In the South the better method is to fasten 2 by 4 horizontal cross-pieces 2 to 2½ feet long to posts, and stretch a wire on either end of these cross-pieces. A third wire is stretched either along the center of the cross-piece, when it becomes known as the "horizontal system" of training, or to the post 6 inches below the cross-piece, when it becomes known as the modified "Munson system" of training. The arms are tied to the center wire in either case and the shoots trained over the other 2, as seen in Fig. 264, showing the side view, and Fig. 265, showing the top view. In a test of different systems of training with Concord, Moore Early, Worden, Ives and Delaware at the Illinois Station (Bul. 28), the horizontal trellis gave the best results, followed by the upright 3-wire trellis. For the use of farmers in Wisconsin, the experiment station of that State recommends that each vine be trained to a post. This permits of horse cultivation both ways.

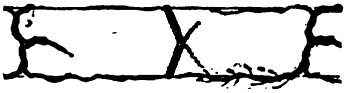


Fig. 265—THE MUNSON SYSTEM OF GRAPE TRAINING, TOP VIEW

Cultivation and Manuring—Grapevines require frequent shallow cultivation throughout the season. In cold latitudes, as in Wisconsin and Northern Michigan, the vines should be taken down off the trellis about the middle of October and pruned. The whole vine should then be bent down to the ground and covered with earth 4 or 5 inches deep. The object of the earth is to keep the vines frozen all winter rather than subject them to repeated freezing and thawing. It is recommended to keep the vines covered as late in the spring as possible, but to uncover before the buds swell enough to break off in uncovering and tying up. (Wis. Sta. Bul. 13.) This can be determined from time to time by uncovering a portion of a vine.

Grapes do not require stimulating fertilizers. Wood ashes, about ½ bushel per vine, is one of the best fertilizers to apply. An application of 3 pounds per vine of the following mixture is recommended by the Georgia Station (Bul. 28): Ninety pounds acid phosphate, 90 pounds kainit and 20 pounds cottonseed meal.

Ringing—Grapevines are frequently girdled or ringed for the purpose of hastening maturity and fruitfulness. Implements for this purpose are shown in Fig. 266. Experiments at the New York State Experiment Station and Massachusetts Agricultural College show that fruit on ringed vines is sometimes 10 days to 2 weeks earlier than on unringed vines, and larger both in bunch and berry. Shoots bearing the bunches are ringed between the fruit and the arm bearing the shoot. Sometimes an entire arm is ringed, but the process is a devitalizing one which should not be practiced with the same vine at most oftener than every other year. The ringing should be done when the grapes are about 1-3 grown, a ring of bark about 1 inch wide being removed from the arm or shoot. (N. Y. State Expt. Sta. Bul. 157.)

Varieties—Probably the most popular grapes grown, both for home table use and the market, are the 2 varieties Concord and Delaware. Experiment stations in the different sections of the country have made extended tests with varieties, and the recommendations of some of these may serve to indicate the best varieties for different sections of the country. In the North, Concord, Niagara, Catawba and Worden. The Virginia Station recommends for table and market Concord, Moore and Early Market among the blacks; Brilliant and Delaware among the reds, and Willie Bell, Niagara, Winchell and Martha among the whites. For red wine, Clinton, Cynthiana and Norton are recommended. The Georgia Station recommends practically these same varieties, and, in addition, for white wine, Goethe, Missouri Riesling, Elvira, Catawba, Herbemont, Delaware and Scuppernong. A perspective view of a vineyard at this station is seen in Fig. 267. The Texas Station recommends Brilliant, Bailey, Delaware, Dracut, Duchess, etc., for table grapes; and American Catawba, Herbemont, etc., for wine. The Missouri Station recommends as early varieties for local and commercial planting Green Mountain, Campbell Early, Jewell, New Haven, Brighton, Moore Early and Norfolk. Wisconsin recommends first of all Moore Early, followed closely by Worden, Concord, Wilder and Delaware. (Ga. Expt. Sta. Bul. 28; N. Y. State Expt. Sta. Bul. 157; N. Y. Cornell Expt. Sta. Bul. 117; Va. Expt. Sta. Bul. 35; Wis. Expt. Sta. Bul. 13; U. S. Dept. Agr. Farmers' Bul. 118.)

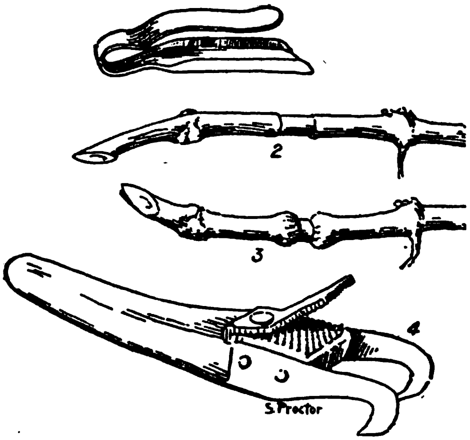


Fig. 266—IMPLEMENTS FOR RINGING GRAPE VINES
(After Paddock)

California Grapes—In California Vinifera or European grapes are grown. These are famed as table, wine and raisin grapes. The gradual spread of the phylloxera to California vineyards and the destruction, in consequence, of these non-resistant varieties, has necessitated the re-establishment of many vineyards on resistant stocks.

Various varieties of the native Rupestris and Riparia, more particularly Rupestris St. George, Riparia Gloire de Montpellier and Riparia Grande Glabre, have been found most resistant and best suited as stocks for the European grapes. The usual method is to grow the native stocks, then cleft-graft at the crown with the European varieties. The State Experiment Station has shown that with many varieties bench-grafting the resistant vines is more satisfactory. The stock cuttings are ¼ to ½ inch in diameter and 6 to 9 inches long. The buds from these are cut out deeply to prevent the growth of suckers. The cions are made about the same size and length, but of course the buds are not removed. The English cleft graft, tied firmly with raffia, has been found most satisfactory by the station. The grafts may be either calloused in sand and then transplanted to the nursery, or planted in the nursery at once after the manner of planting grape cuttings in the East. The best results are secured, however, when the grafts are first calloused in sand. All roots arising from the cions must be removed for the first 2 or 3 years. In planting vineyards on resistant stocks it is essential that the ground be plowed about twice as deep as where European varieties are grown on their own roots. Neglect of this principle has resulted in many failures. California methods of pruning Vinifera grapes are considerably different from the methods observed with native grapes. The vines are pruned to low, stocky stumps, as seen in Fig. 268. The canes are either not trained at all or are trained to stakes. Trellises are not used.

There are many varieties of European grapes for the different purposes of making wine and for the table and raisins. Some of the more prominent of these are the following: *Raisin Grapes*—White Muscat of Alexandria, Muscatel Gordo Blanco, Sultana, Thompson Seedless. *Table Grapes*—Flame Tokay, Emperor, Black Hamburg, Chasselas. *Red Wine Grapes*—Zinfandel, Carignan, Mataro. *White Wine Grapes*—Sauvignon, Riesling, Chasselas Dore. *Port Wine Grapes*—Mission, Malvoisie, Trousseau. *Sherry and Madeira Wine Grapes*—Mission, Palomino, Sultana.

Grapes are also grown under glass. For this purpose only European varieties are used. Black Hamburg is the variety most used for this purpose. (Cal. Expt. Sta. Buls. 127 and 146.)

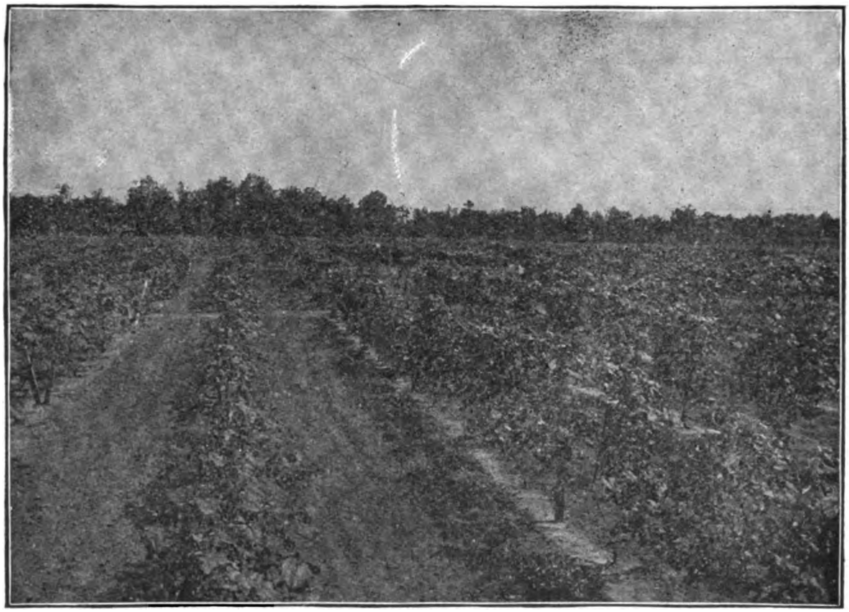


Fig. 267—EXPERIMENTAL VINEYARDS IN GEORGIA
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

Enemies: DOWNY MILDEW (*Peronospora viticola*), also known as brown rot and gray rot, attacks leaves, young wood, flowers and berry. On the leaves it appears as green-yellow spots on the upper surface, with white spots on the under side. The white substance disappears and the leaves turn brown and dry up. The downy stage is more pronounced on the flowers and young wood. The disease occurs in 2 forms on the fruit, as brown-purple spots which finally involve the whole berry. In gray rot the berry is covered with a white powder, and the berries in a cluster become fastened together by the fungous threads.

Spray with ammoniacal solution of copper carbonate or eau celeste, before flowering, soon after flowering, and then at intervals of from 2 to 4 weeks.

Powdery Mildew (*Uncinula spiralis*) is an external parasite, attacking the leaves, new growth and berries in midsummer. Affected parts are covered by a felt of white threads, by which this disease may be distinguished from downy mildew. The fruit sometimes cracks open when attacked. If the fungus is rubbed off, the affected parts of the plant are seen to be brown. The disease is not so serious that treatment need be undertaken before the fungus appears. It yields readily to spraying with ammoniacal solution of copper carbonate. Sulphur dusted on the plants will check the disease, but is not very satisfactory as a practical remedy.

Anthracnose (*Sphaceloma ampelinum*) attacks all green parts of the vine during the growing season. On grape shoots the trouble appears as sunken oval areas. Black or brown spots appear on the leaves and the diseased tissue often cracks, leaving ragged holes. On the fruit the disease appears as brown spots, with a narrow, darker margin. The vines and stakes may be washed with a solution of copperas in winter and spring. In addition to this treatment, regular summer applications should be made with standard fungicides.

Black Rot (*Guignardia Bidwellii*) first appears as brown or black spots on the leaves and shoots. Soon afterward the berries are attacked and finally become black, hard and leathery. This disease may be completely controlled by repeated sprayings with Bordeaux mixture, beginning before the first symptoms are noted. The effects of spraying are seen in Fig. 269.

Ripe Rot—See *Apple Bitter Rot.*

Leaf Blight (*Cercospora viticola*) is recognized as large, irregular red or yellow spots on the leaves after the grapes have been picked. The leaves fall prematurely, and thus the proper ripening of the wood is prevented. Since the fungus winters over in fallen leaves, such material should be collected and burned.

Root Rot (*Armillaria mellea*) causes a sickly appearance or death of the vines. The fungus may be recognized on the roots as brown fibers. The fruiting body of the fungus is a mushroom. Diseased vines should be dug out and burned. Chips should not be used as a mulch, since such material may be infected with the disease.

White Rot (*Charrinia diplodiella*) attacks the fruit on the stem of a cluster. Spots appear on the berries, which are at first red, then white, and finally brown. The disease may be held in check by spraying with Bordeaux mixture.

Crown Gall—See under *Apple.*

Of the grape diseases mentioned above, the first 4 are most common and most important.

California Vine Disease affects all parts of the vines. The leaves fail to develop their usual green color, but show bright red or yellow stripes between the principal veins. The canes are stunted and exhibit brown flattened streaks along one side. Such areas become black, the bark and wood dry up and the cane may be readily snapped off. The cause of this disease is not known. Repeated spraying with Bordeaux mixture seems to have a beneficial effect in some cases. By some the disease is thought to be due to disturbed nutrition of the vine, and careful attention to fertilizers and to moisture conditions is urged.

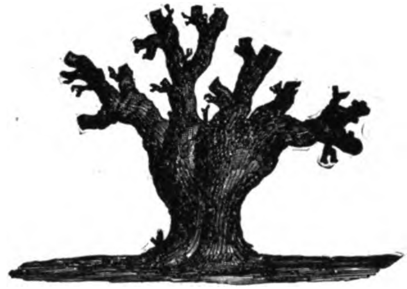


Fig. 268—CALIFORNIA SYSTEM OF PRUNING

Brunissure appears as brown, star-shaped spots between the veins on the upper side of the leaves. These spots increase in size and cause the leaves to fall prematurely. The cause of the disease is not definitely known, but it is considered due to physiological disturbances. The California vine disease is probably of a similar nature and treatment should be the same.

Shelling of grapes appears as a mottling and thickening of the skin. Just under the skin the flesh is brown and the whole berry is insipid. The fruit falls 2 or 3 weeks before ripening, as seen in Fig. 270. Weakening the plants from other diseases, poor root system, prolonged drouth and lack of potash in the soil are usually considered as causes of this disease.

Phylloxera is a common insect on wild grapes in this country, and after its introduction into Europe attracted much attention on account of its ravages upon cultivated varieties. It occurs in 2 forms, one producing galls on the under side of the leaves, and the other living upon the roots, where it causes similar swellings. The latter form causes the real injury, although it is less frequently seen than the leaf form. The root galls first appear on the small rootlets, but ultimately the whole root system is destroyed and the plant dies. The species is distributed by means of winged females, which fly to new vines in late summer or fall. In California the species has recently become injurious to the less resistant varieties of cultivated European grapes. The commonest method for combating this insect consists in the use of bisulphid of carbon in the soil. This substance is injected from 8 to 12 inches below the surface and the fumes destroy the insect. The most satisfactory method of preventing injury from phylloxera is to use resistant stock, of which the wild varieties of *riparia, aestivalis* and *labrusca* are most important.

Grapevine Fidia is a brown beetle about 1/4 inch in length, covered with short gray hairs. In June and July the beetles eat holes in the leaves, falling to the ground when disturbed. The grubs of this species live in the soil and feed upon the grape roots. The beetle occasionally attacks the flowers. Grapevines infested by the larvae at the roots appear sickly. The adult beetles should be destroyed by spraying with Paris green, and the larvae may be killed by injections of bisulphid of carbon in the soil near the stems, or by wetting the soil about the vines with a solution of kerosene emulsion.

Grape-Cane Gall-Maker (*Ampeloglypter sesostris*) is a curculio 1/8 of an inch long, reddish-brown and black in color. The female punctures the stems and deposits her eggs in June and July. The grubs feed within the galls which are thus produced on the stems. The insect winters over in the adult stage under rubbish. The Concord variety is perhaps most affected by this species. Infested portions of vines may be cut off and burned and rubbish in vineyards should be destroyed.

Cane Borer (*Amphicerus bicaudatus*) is to be recognized as the cause of a sudden breaking off or drooping of young grape shoots in the spring. The adult insect is a brown beetle, about 1/2 inch long, which burrows in the stem. The species attacks many other plants in a similar manner, especially the apple, but

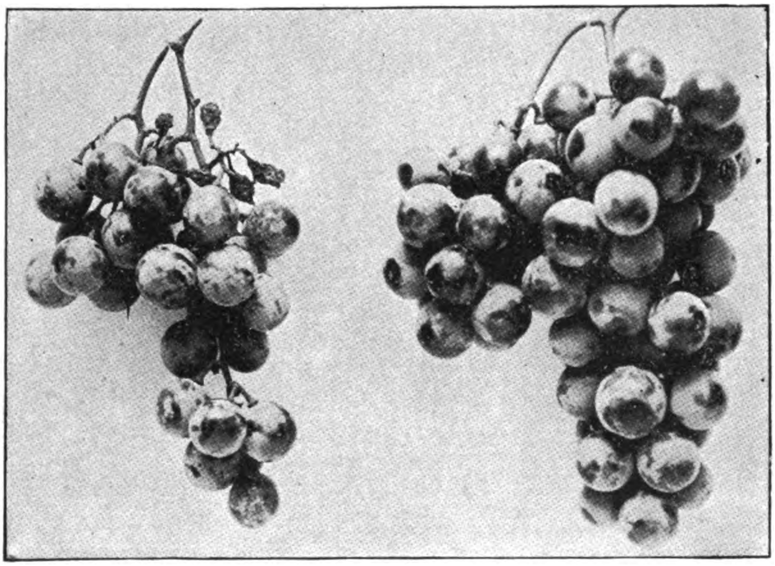

Unsprayed Sprayed

Fig. 269—BLACK ROT
(From N. Y. Cornell Expt. Sta. Bul. 76)

is perhaps most destructive to grapes. In order to prevent the ravages of this insect it is necessary to destroy all wood in which it may breed. Diseased wood in pruning should be removed and destroyed by midsummer.

Rose Chafer (*Macrodactylus subspinosus*) is a brown beetle 1-3 of an inch in length, which appears in large swarms, eating the blossoms and leaves of grapes and many other species of plants. The immature stages of this insect are passed in grass lands, where it feeds upon the roots of grasses. Spraying with arsenicals is of avail only when the beetles are not numerous. Nearly all substances applied to the vines to render them distasteful to the beetles have proved useless. Vines may be temporarily protected with netting. Since this beetle is especially fond of the flowers of spiraea, this plant may be grown in the neighborhood of vineyards and the insects collected from these plants. They may be gathered in large beating nets or jarred into funnel-shaped collectors.

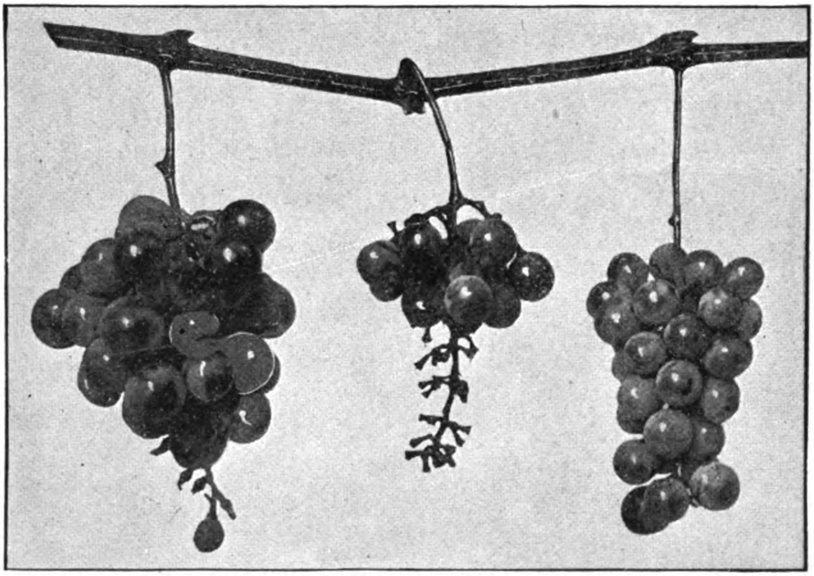


Fig. 270—GRAPE SHELLING
(From N. Y. Cornell Expt. Sta. Bul. 76)

Leaf Folder (*Desmia maculalis*) is to be recognized by the presence of folded leaves in midsummer. This condition is especially striking in thick-leaved varieties. The caterpillar which causes the trouble is of a greenish color and about ½ inch long. The moth into which the caterpillar transforms is shining black, with a white edge on the wings and 4 white spots. Folded leaves may be readily detected and the caterpillars in them may be destroyed. Since the insect winters in the chrysalis condition in folded leaves which have fallen to the ground, considerable good may be done by collecting and burning such leaves.

Berry Moth (*Eudemis botrana*) attacks the fruit while young and feeds upon the inside of the berries, causing discolored spots which are visible from the outside. The berries are fastened together by threads spun by the larvae of this insect. When full grown the larva leaves the fruit and rolls itself up in a portion of the leaf, in which it changes to a chrysalis. This insect attacks all varieties of grapes, but is especially injurious to the varieties with thinner skins. The first brood is rarely noted. Spraying with poisons is not practicable except for the first brood, which feeds on the green parts of the vines. Infested fallen fruit should be collected and destroyed, and fallen leaves should be burned in the autumn.

Sawfly (*Selandria vitis*) in the larval condition is about ½ of an inch in length and of a yellow green color, with black spots. When present in large numbers the larvae may be destroyed by arsenical poisons or white hellebore.

Leaf Hoppers—These insects belong to the same general class with plant lice. They are usually of a pale yellow or green color, are about 1-10 of an inch long, and the young resemble the adults except in size and in the lack of wings. They feed in all stages on the leaves of plants. Leaf hoppers attack cereals, grasses, other forage plants, fruit trees, etc. When present in large numbers they cause the leaves to turn yellow and die. On grasses they may be very injurious.

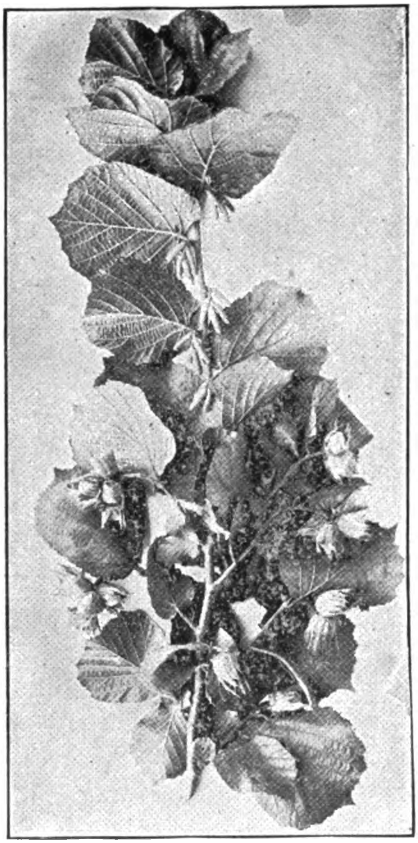


Fig. 271—IMPROVED ENGLISH HAZELNUT OR FILBERT
(From Ore. Expt. Sta. Bul. 52)

Spraying with pyrethrum, kerosene emulsion or tobacco decoction is effective against leaf hoppers. In greenhouses they may be destroyed by fumigation with tobacco, pyrethum or hydrocyanic-acid gas. They may be captured at night by lantern traps. The use of a hopper-dozer, as recommended for locusts, is also a good remedy. The eggs are prevented from hatching if the grass is cut while quite green. Badly infested fields should be burned over in fall or winter. (Iowa Expt. Sta. Buls. 13, 15, 20, 34.)

For **Flea Beetle** see under *Beets.*

HAZELNUT (*Corylus* spp.)

Also called filbert and cobnut. Native hazelnuts occur in nearly the whole of the United States. They are familiar as low, shrubby growths in old pastures, fence rows and partial clearings. The nuts mature in the fall and are easily gathered after the first frost. They vary much in size, but are usually rather small. Most of them are gathered by children and seldom find their way to market. The native nuts have come only sparingly into cultivation, and thus far no varieties have developed worthy of naming or propagation. Some varieties of foreign hazelnuts are much larger than the native nuts. Many of these have been cultivated in the Eastern United States, but generally without profit. In Washington and Oregon, however, much better results have been obtained. The Oregon Station estimates the product of an acre of 7-year-old trees at 1600 pounds of nuts, having a value at 6 cents per pound wholesale of $96 per acre. Its more extended culture in the Willamette Valley is urged. (Ore. Expt. Sta. Bul. 52.)

Hazelnuts are propagated by seed, cuttings, layering and grafting. The seed of improved varieties does not "come true." Propagation by cuttings is most usual. These are cut 8 to 10 inches long from last year's wood and rooted in moist, sandy soil in the same manner as currants or gooseberries. Grafting the improved varieties on the common hazelnut is sometimes practiced. By this process the fruiting period is materially hastened. In Oregon cuttings 15 to 20 inches long are recommended, and all buds except 2 or 3 at the upper end carefully removed. Where this precaution is observed it prevents the plant from throwing up suckers, which it has a tendency to do. In the nursery row the sprouts and branches are kept removed from about the base to a hight of 12 inches. At this hight the head of 5 or 6 stems is allowed to develop on the main stem. After 2 years in the nursery rows the trees are set in the permanent orchard 15 feet apart each way. Hazelnuts grow on nearly all soils, but fruit most abundantly on the lighter loams.

Pruning is essential to the largest production of nuts. Young shoots should be cut back to about half their length each winter. This induces the formation of laterals along the main branches, on which the fruit is borne.

The nuts are gathered for immediate use as soon as the husk begins to turn brown, but are not gathered for keeping until they are ready to drop from the tree. They should be stored perfectly dry and are generally marketed with the husk on. Among the better varieties are White Filbert, Barcelona, Grandis, Lambert and Purple Leaved Filbert. A fruiting branch of hazelnut is seen in Fig. 271.

HICKORY (*Hicoria* spp.)

This subject will be discussed from the standpoint of nut culture. In the Northern States the shagbark (*H. ovata*) and shellbark (*H. laciniosa*) are the most common forms of this nut tree, while in the Southern States the pecan (*H. pecan*) is the variety of most value. So much attention has lately been given to the culture of the latter nut that it will be considered more at length under that head. (See *Pecan.*)

The hickories are native forest trees, growing wild from Southern Maine west to Minnesota and south to the Gulf States. The wild nuts vary much in size, form, quality and thickness of the shell. It is probably owing to the rather thick shell, taken in connection with the slow growing habit of the trees and their difficulty of propagating by grafting and budding, that so few varieties have been introduced into cultivation. Practically all the nuts of commerce are from wild trees. They are gathered mostly by children and sold to the local markets, where they bring from 75 cents to $1.25 per bushel. A specimen of the typical Western Shellbark Hickory is seen in Fig. 272. Of the few varieties brought into cultivation, Hale's Paper Shell, Curtis, Eliot and Ideal are among the most valuable. A picture of the original Hale's Paper Shell Hickory tree is seen in Fig. 273. The desirable qualities of a hickory nut are a thin shell and a meat of good quality easily gotten out. The shellbarks and shagbarks are cultivated and propagated the same as the pecan. (See *Pecan.*)

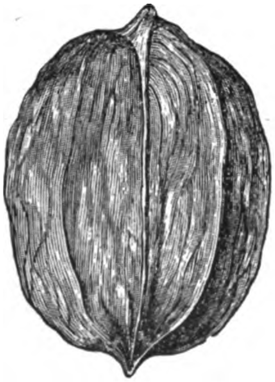


Fig. 272—SHELLBARK HICKORY

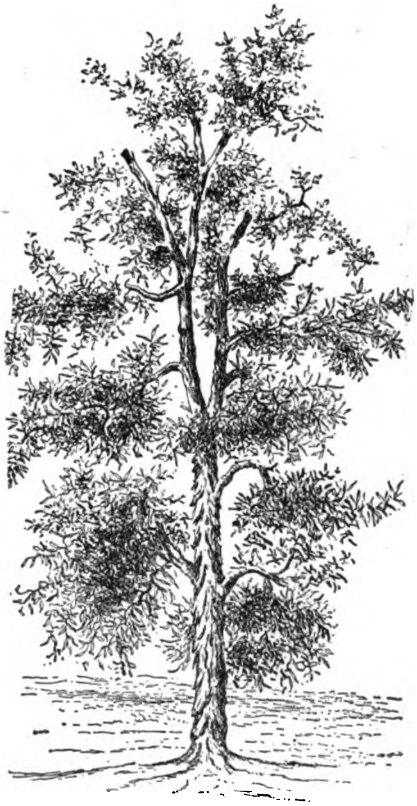


Fig. 273—ORIGINAL TREE OF HALE'S PAPER SHELL HICKORY

Enemies: HICKORY BORER (*Cyllene pictus*) is a white grub ½ inch long, which bores in the trunk of the hickory. The beetle appears in June. It is a little over ½ inch in length, with long antennae, of a brownish color, mottled with white. As soon as the burrows of this insect are detected the grub may be cut out with a knife or killed by means of a flexible wire. The hickory is also subject to the attacks of other species of tree borers, various specimens of leaf-eating caterpillars, the hickory nut weevil and other insects. For the treatment of weevil see under *Chestnut*.

LOGANBERRY

A fruit supposed to be a hybrid between the Aughinbaugh blackberry and a red raspberry, probably Red Antwerp. (Fig. 274.) It was originated by Judge J. H. Logan at Santa Cruz, Cal., in 1881. The fruit has many characteristics of both parents. It is a rich dark red color and often 1½ inches in length. The fruit is more valued for the home garden than for market. In the East it requires winter protection. It is propagated by stolons and from single eye hardwood cuttings and trained on some form of trellis. In general its culture is like that of raspberries and blackberries. (See also R. I. Expt. Sta. Bul. 45.)

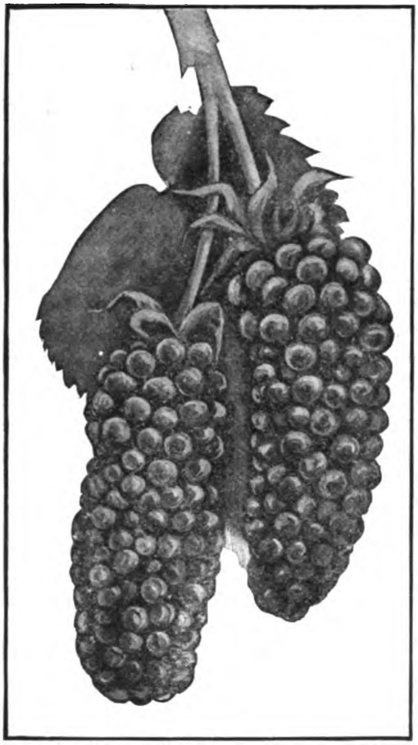


Fig. 274—THE LOGANBERRY

MEDLAR (*Mespilus Germanica*)

A dwarf tree or shrub 10 to 15 feet high, yielding a small austere fruit of the same name. The medlar is little grown in the United States, but is common in some parts of Europe. It is perfectly hardy in the Northern States and is reported as yielding well as far north as Agassiz in British Columbia. Botanically the medlar belongs to the same family as the apple. The form of the fruit and leaves is well shown in Fig. 275. The tree will grow in any good soil with ordinary cultivation. Varieties are propagated by grafting on pear or quince roots or seedlings. Seed of the medlar usually requires 2 years to germinate and will not reproduce varieties true to name. The fruit does not ripen until late fall after frost comes. It is then packed and laid in a cool, dry place away from draughts of air until it becomes mellow. It has an acid flavor and is used for eating out of hand and for preserves. Dutch is one of the largest varieties and may attain a diameter of 1½ to 2 inches. Nottingham is a smaller variety, but of better flavor. Of a number of varieties tested at Agassiz in British Columbia a variety known as Large Fruited proved of as good quality as any and was much the largest and smoothest sort grown.

MULBERRY (*Morus* spp.)

The mulberry is little grown in this country. The home demand for the fruit is small and the market demand still smaller. The fruit can be successfully grown on nearly all soils and the tree is very hardy both North and South. Some varieties possess considerable merit for ornamental planting, for hedges and for windbreaks. The mulberry furnishes leaf food for the silkworm.

Mulberries may be propagated by cuttings of the ripe wood or of roots. Nurserymen usually propagate improved varieties by grafting on Russian mulberry roots. Early spring grafting with entirely dormant cions is one of the most successful methods of grafting the mulberry. The mulberry tree grows to about the size of an apple tree, and in orchards should stand 20 to 32

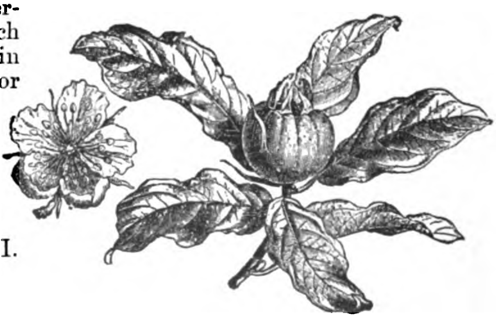


Fig. 275—MEDLAR FRUIT AND FLOWER

feet apart. For home use 2 or 3 trees will be sufficient.

The fruit drops when ripe and may be gathered by shaking the trees and catching on sheets or grass. The fruit is soft and rather sweet, much relished by birds, and ripens through a period of 6 weeks or more. In some cases it may be desirable to plant a few mulberry trees to furnish fruit for birds and thus protect more valuable fruits.

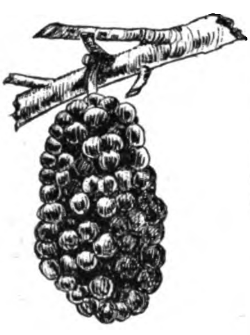


Fig. 276—NEW AMERICAN MULBERRY

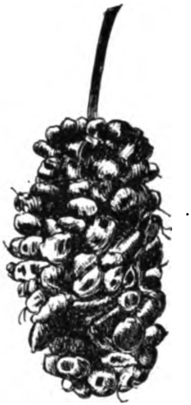


Fig. 277—DOWNING MULBERRY

New American (Fig. 276), Downing (Fig. 277), Thorburn and Trowbridge are the varieties usually grown in the Northern States for fruit. Farther south Black Prussian and Hicks are more often grown. Hicks is a heavy bearer, but the fruit is of inferior quality. The Russian mulberries are especially valuable for ornamental hedges in the Western prairie States, especially in cold regions, and for small ornamental trees. The Chinese varieties used for feeding silkworms belong to the species *M. alba* var. *multicaulis*. For the botany of mulberries and descriptions of varieties see N. Y. Cornell Expt. Sta. Bul. 46. For methods of propagating mulberries see U. S. Dept. Agr. Bureau Plant Industry Bul. 34.

Silk Culture—The business of raising silkworms has never been developed to any great extent in the United States. Small attempts along this line have been made in California, Utah, Kansas and elsewhere. The majority of such enterprises have been abandoned on account of the high price of labor. As is well known, the world's supply of silk is at present produced by cheap labor in Europe and Asia.

An appropriation has been secured by the Secretary of Agriculture for the purpose of testing the possibility of producing silk economically in the Central and Southern States. It is believed that the work of feeding silkworms could be done by colored children at a very low price. Mulberries are already planted extensively in this country, and it has been shown that osage orange equals mulberry as food for silkworms. There are thousands of miles of hedge composed of osage orange, and the tree grows wild from Missouri to Texas. The income from silk raising is not sufficient to warrant the ordinary farmer in engaging in the business until further experiments have been made. The silkworm in its various stages is seen in Fig. 278.

NECTARINE (*Prunus Persica nectarina*)

This is a smooth-skinned peach. It is inferior in quality to the peach and is little grown commercially except in California, and there only on a small scale, principally for drying and canning. It will grow wherever the peach will grow and is cultivated in exactly the same manner. Peach stock has been found desirable for nectarines in California on alkali soils.

There are but few cultivated varieties, the more prominent of which are Boston, Dawnton, Advance, Hardwick, etc.

For enemies see under *Plum, Peach* and *Apple.*

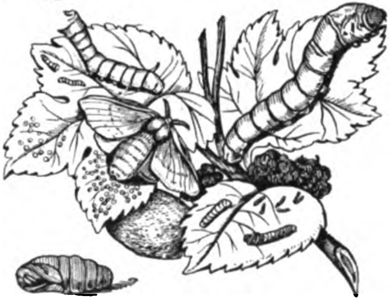


Fig. 278—VARIOUS STAGES OF THE SILKWORM

OLIVE (*Olea Europaea*)

During the past 20 years the olive has become of considerable commercial importance in California. Elsewhere it is little grown in this country. The olive tree is a slow-growing, long-lived evergreen, with small, narrow, lanceolate leaves. It produces the pickled olives and olive oil of commerce. The tree sometimes lives to be hundreds of years old. It is very productive. It has a somewhat rounded form and sometimes attains a hight of 40 feet. It is considered dangerous to plant olives where the temperature falls below 20° F. It succeeds best within 100 miles of the sea and where the mean temperature of the coldest month does not fall below 43° F. At a temperature of 10° F. the tree is killed. The olive thrives best in a light, well-drained sandy or loam soil rich in potash and lime. It is frequently planted on soils so rocky that nothing else but a vine could succeed in them. The tree is deep-rooted and withstands drouth better than other fruit trees, but in California experience, where the rainfall is light, irrigation must be practiced if profitable crops are produced. The fruit is inferior on heavy clays or moist lands. A bearing branch of the Mission olive, reduced in size, and a single fruit, natural size, are seen in Fig. 279; and an old Mission orchard in Fig. 280.

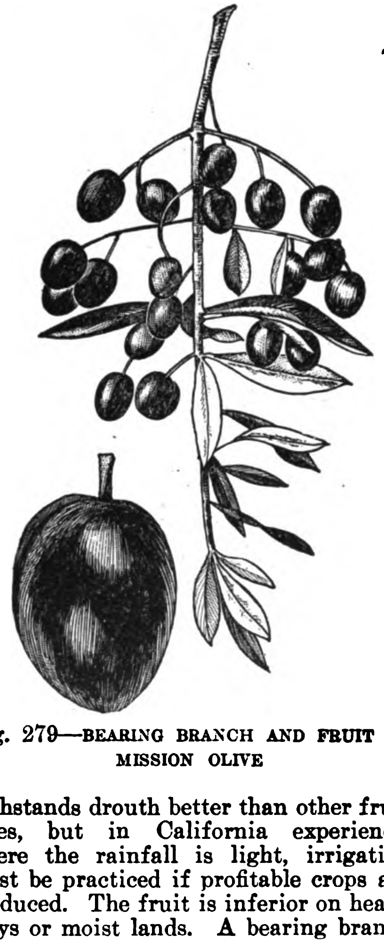


Fig. 279—BEARING BRANCH AND FRUIT OF MISSION OLIVE

Propagation—Olives are propagated by all the usual methods of growing fruit trees. They are usually propagated from cuttings, though the best rooted, longest lived and heaviest bearing trees are grown from seed. When grown from cuttings, young well-hardened shoots several inches long are taken from strong growing trees, all the leaves removed except 2 or 3 at the top and planted in shallow boxes of sand placed either in a greenhouse or some warm, shady place and kept moist. Thus treated the cuttings readily root, and may be transplanted to the nursery at the end of 3 or 4 months. Here they should remain 3 or 4 months longer and then be transplanted to their permanent position in the orchard. Thus handled trees are produced that sometimes yield fruit within 4 or 5 years from the time the cuttings are placed in the sand.

When trees are grown from seed, the shells should either be cracked or else soaked for 24 hours before planting in a weak lye solution to soften them up. Otherwise the seed will remain in the ground 2 years before germinating. Seed that float are worthless and should not be planted. Plant heavy seed 1 inch deep and 3 inches apart in 6-inch drills and surround the pits with well-rotted stable manure. Transplant to the nursery when the seedlings have developed 5 or 6 leaves, cutting back the roots about half. The second spring after planting crown-graft just below the surface of the ground with improved varieties, using 2-year-old wood and the wedge method of grafting. One year after grafting the trees may be set in their permanent positions in the orchard. Trees grown from seed do not come into so early bearing as when grown from cuttings.

In improving old trees either grafting or budding may be practiced. If budding is practiced, the buds should be taken from healthy wood and inserted in vigorous shoots. Dormant twig buds are best. They should be cut deep, part of the wood removed and inserted by the ordinary T method of budding. Two-thirds of each leaf should be also removed to lessen evaporation from the twig. After the cion has united, the branch above it should be removed. Budding is most successfully done in early summer or spring when the sap is flowing most freely. With old trees it is advisable to cut back the larger limbs and bud the sprouts that arise. Only a part of the tree should be cut back in any one season and the remainder the next. If all the limbs are removed at once the tree may be killed.

Cultivation—Good cultivation has been found as essential in California practice to the production of profitable crops of olives as with any other orchard fruit. Irrigation is also just as essential. The olive is sensitive, however, to an excess of water, but it requires as much water as other fruit trees.

Pruning—Yearly light pruning of the olive is now considered advisable rather than the customary no pruning or occasional heavy pruning. The smaller varieties should be headed out about 3 feet from the ground and given a spherical head, and larger varieties 4 to 5 feet from the ground and given a goblet form. The essential fact to remember in olive pruning is that the fruit is borne only on wood of the preceding year's growth and never twice on the same wood. Also that vertical branches which the tree normally tends to produce usually give nothing but wood; but when these branches are deflected from the vertical they become enfeebled and produce more fruit.

The olive tree may be pruned at almost any season, but immediately after harvesting is believed to be the best time, as at that time no fruit is lost. Young trees should be pruned twice yearly and vigorous shoots on heavily fruited trees pinched back.

Harvesting—Olives intended for green pickles should be harvested soon after reaching full size, but before they begin to color or soften up. For ripe pickles and oil the fruit should be picked soon after becoming well colored, but before becoming black. The fruit should be gathered by hand and carefully graded. If used for oil it should be washed.

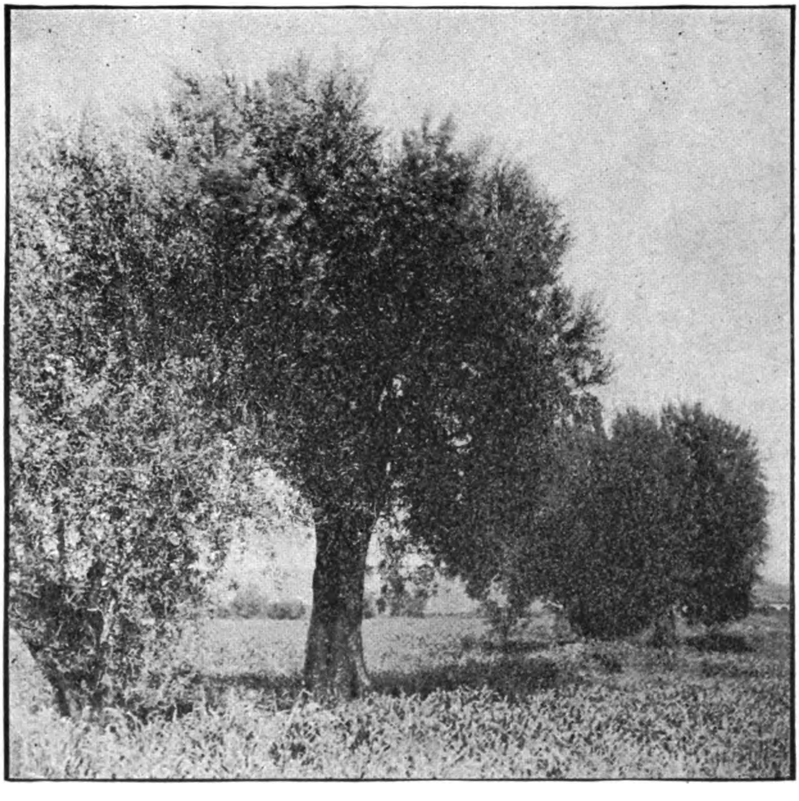


Fig. 280—OLD MISSION ORCHARD IN CALIFORNIA

Olives are pickled by first soaking in a weak potash lye solution to remove the bitterness in them and afterwards preserved in brine. The proper strength of lye and salt solutions to use has been studied at length by the California Station, and as this is somewhat of a technical process the reader is referred to Bulletin 137 of that station for a further account of it. Ripe olives make the best and most nutritious pickles. They are a food, while green olives are of value simply as a relish.

Varieties—Some 70 varieties of olives have been grown in California. The experiment station considers Sevillano, Mission, Picholine, Manzanillo and Gordal the best varieties for the production of commercial ripe pickles. These and other large sized sorts are good olives for green pickles. Rubra and Pleureur de Grosse are considered excellent oil varieties. The use of olive oil as a salad is well known. For further account of olive growing, pickling and the commercial condition of olive culture in California see Cal. Expt. Sta. Buls. 123, 129 and 137 on olive culture.

Enemies: KNOT OR TUBERCULOSIS (*Bacillus oleae*) is characterized by the development of numerous knots or warts on the leaves, trunk and branches. On the leaves the knots are very small and mostly on the lower side. On the branches and trunk they vary in size, but may be 2 inches in diameter. The conditions favorable for disease are too much pruning, irrigation and hot weather. No buds or cuttings should be taken from infected orchards. Pruning shears should be disinfected so as not to carry the disease from tree to tree.

DRY ROT is recognized by the presence of black spots and cavities near the pit of the olive. The central portion becomes brown and dries up. The disease develops most rapidly after the olives are picked. It is confined to the Nevadillo Blanco variety. It is recommended that the trees be kept free from scale insects and be sprayed with Bordeaux mixture.

Olives are also attacked by scab, sooty mold and bacterial rot, but these diseases are seldom serious.

The chief insect enemies of the olive are bark lice. (See *Scale Insects,* under *Peach.*)

TWIG BORER (*Polycaon confertus*) bores into the smaller twigs at the base of the buds. Infested twigs may usually be recognized and should be cut off at pruning time and burned.

PEACH (*Prunus Persica*)

The peach is grown over a wide range of country, but its successful commercial culture is limited to a comparatively few localities, viz., Western Michigan, Northern Ohio, Western New York, New Jersey, Delaware, Maryland, Northern Georgia and Alabama, portions of Southern Illinois and southwest into Missouri, Arkansas and Kansas, Eastern Texas, Western Colorado and California. The main difficulty in growing the peach lies in the early swelling and blossoming habit of the flower buds. A week or so of mild weather in winter or early spring may start the buds into growth, only to be killed by subsequent frosts. The danger is even greater in the South than in the North, since the winters are warmer and the buds start into growth earlier. The tree itself is hardy and will thrive where the winter temperature does not fall more than 18° F.

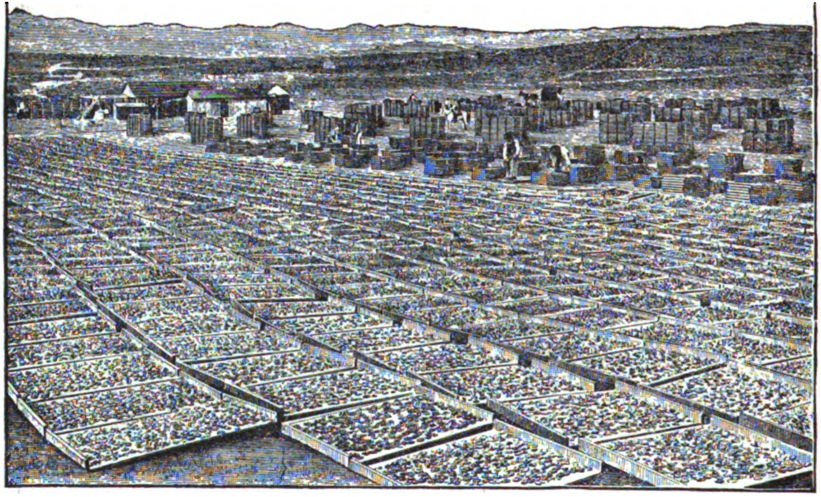


Fig. 281—FRUIT DRYING, CALIFORNIA

below zero. In California the drying of peaches is an important industry. A fruit drying scene in San Bernardino county, Cal., is seen in Fig. 281.

Location of the Orchard—One of the main problems in peach culture is to select a location for the orchard where the buds are least likely to start into growth and bloom before settled weather comes in the spring. In Western Michigan the presence of a large body of water tempers the severity of the winter, and at the same time prolongs the cool weather of spring, thus delaying the blossoming period and lessening the danger from late frosts. This fact assures Western Michigan of a peach crop nearly every year. In the interior of the State peach growers select elevated lands and plant on northern and western slopes where possible. This plan is followed by growers in other States. The rule is to avoid low lands for peaches; late frosts are severest there. Orchards planted on sunny southern slopes come also into earlier bloom and are more likely to be injured by late frosts. Avoid such situation when possible. A high situation, where the cold air will flow off down to lower levels, and a northern or western aspect is generally the best location for the peach orchard. A successful peach orchard in Michigan is shown in Fig. 282.

Soil—The best soil for the peach is a well-drained, rich, sandy loam, but peaches can be grown on nearly all soils. The poorest soil for peaches is a heavy, compact clay. They do well on gravelly loams. Good orchards are often found on exceedingly stony and rocky lands and on soils so poor as to be almost worthless for anything else. On the richer soils the wood growth is apt to be excessive. The orchard should be plowed deeply and put into a good condition of tilth before the trees are set.

Propagation—Peaches are propagated from seed and the seedlings budded with the improved varieties. A few varieties come practically true from seed and do not require budding. The seed are gathered and stratified with sand in the fall and exposed to the action of frost over winter. The following spring they are planted in the nursery 6 to 8 inches apart in rows wide enough to admit of horse cultivation and covered about 2 inches deep. In August or September trees in the North will be ready for budding. Use well-matured buds and bud close to the ground, according to the method described under *Grafting.* Fall-set buds remain dormant over winter and start

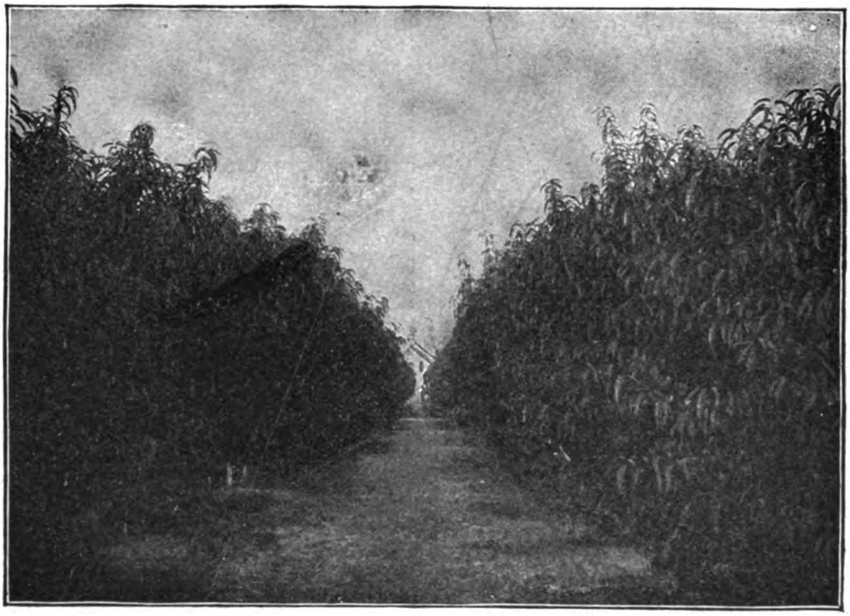


Fig. 282—PEACH TREES AT SOUTH HAVEN SUBSTATION, MICH.
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

into growth the following spring. In the fall the trees will be ready to transplant into the permanent orchard. Such trees are known as 1-year-old stock and are the best for setting in the orchard. In the South trees are also budded in June. Small growers should buy their stock from a reliable nurseryman rather than attempt to grow it.

Planting—In the permanent orchard the trees should stand 12 to 18 feet apart each way. Strong growing varieties on heavy soil are set farther apart than small growing varieties on lighter soils. Spring setting is generally recommended. In setting the trees broken and injured roots should be cut off and the hole dug wide enough so that the roots will not be cramped. In some Southern States some growers prune all the roots back to stubs less than 2 inches long and cut the top back to a straight stick 12 to 18 inches long and secure very good results; but this method has not proved generally satisfactory elsewhere. The trees should be set a little deeper than they stood in the nursery row. The correct method of pruning the tree when it is set in the orchard is shown in Fig. 283.

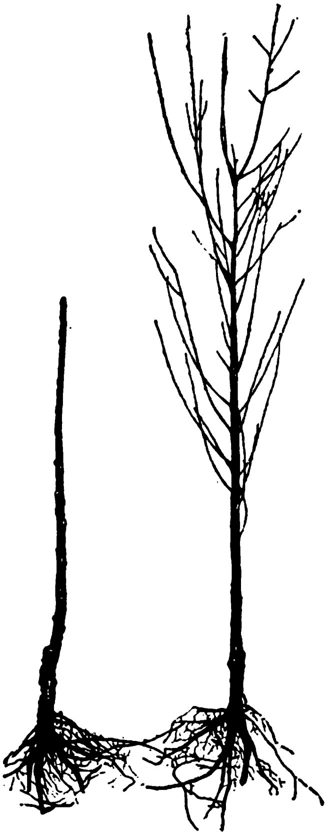


Fig. 283—PROPER METHOD OF PRUNING PEACH TREES WHEN SET IN THE ORCHARD
Tree on the left ready for planting (after Taft)

Cultivation—For the first 2 or 3 years after the peach orchard is set out hoed crops, like beans, melons, etc., may be grown between the rows of trees and the trees kept cultivated, but after that the whole space should be given entirely to the trees. No grain crop should ever be grown in the orchard, nor should it ever be seeded down. In general the peach orchard should be plowed each spring and kept thoroughly cultivated during the summer up until about the first of August, when cultivation should stop, and some cover crop be sown. The purpose of the shallow cultivation every week or 10 days throughout the summer besides supplying plant food is to keep the orchard covered with a dust mulch and preserve the soil moisture for the use of the tree. (See *Mulch.*) Cultivation is stopped in August and a cover crop sown in order to check growth, ripen up the wood of the tree and lessen the danger from winter injury. When the cover crop is turned under in the spring it adds considerable humus to the soil, and if a leguminous crop like crimson clover, hairy vetch or peas has been used it adds nitrogen to the soil.

Fertilizers—Potash and phosphoric acid are the most important fertilizers for the peach. Nitrogen is of less importance. If leguminous cover crops are grown in the orchard these will supply all the nitrogen necessary on ordinary soils. On light soils a dressing of 25 tons of well-rotted stable manure applied every other year will make up for any deficiency of nitrogen. So long as the trees make a good growth each season and the leaves have a deep green color the trees are not suffering for nitrogen. If the barnyard manure is supplemented with 100 bushels of unleached hardwood ashes the peach orchard will be fairly well provided with plant food. If commercial fertilizers are used a bearing orchard will require every 2 years from 300 to 500 pounds ground bone, 200 to 300 pounds muriate of potash, and on light soils 150 pounds nitrate of soda.

Pruning—At the end of the first season in the orchard the young tree will have sent out many branches. Early the following spring 4 or 5 of the strongest of these which come out at different points around the stem should be chosen to form the head and the remainder removed. If the branches come out at different points there is less danger of the limbs splitting down later when they become loaded with fruit. The head should be started low, 2 to 2½ feet from the ground. The branches selected for the head should be cut back about half their length. The leader should be a strong upright-growing branch and left a little longer than the others so that other side branches may be sent out from it. Subsequent pruning will consist largely in heading in the annual growth, and removing dead or undesirable branches. In this connection it is well to remember that fruit is borne one season on wood that was made the preceding season, so if the winter has been severe and only a few scattering buds are alive, only the ends should be slightly headed in; but if all the buds are alive the spring pruning should consist in removing one-half or two-thirds of the growth of the preceding summer. In this way the tree is kept in a low compact form from year to year so that most of the fruit can be gathered while standing on the ground and the work of thinning and spraying is greatly reduced.

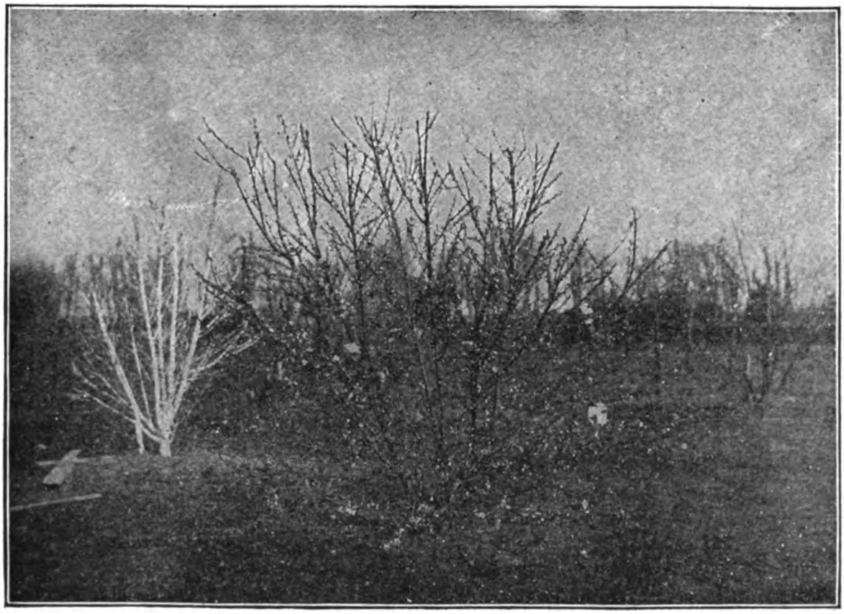


Fig. 284—WHITEWASHING PEACH TREES TO RETARD BLOSSOMING AT THE MISSOURI STATION
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 80)

Thinning the Fruit—If left to themselves many varieties of peaches set more fruit than they can properly mature. This weakens the tree, tends to the production of crops only in alternate years, and the fruit is inferior in size and marketableness and more subject to rot. The best growers thin the fruit and are well repaid for it in the larger size of fruit and better prices received. Thinning should be done just before the pits begin to harden, or when the fruit is as large as the end of the thumb in June or July. The poorer or diseased fruits should be removed first. If the limbs have not been headed back the peaches should be thinned to 6 inches apart; but if the fruit has been partially thinned by heading back at the spring pruning, the fruits may be left closer together than this. One grower states that 800 peaches is sufficient for 1 tree to mature.

Winter Protection of Peaches—In many sections where the climate is unfavorable to peach production, successful crops are grown by protecting the trees over winter either from severe cold or the various climatic changes. The Missouri Experiment Station found that if peach trees were thoroughly sprayed with whitewash in the fall, the trees absorbed less heat on sunny days during the winter, the buds remained practically dormant, while buds on untreated trees swelled perceptibly during warm days in February and March, and they blossomed 3 to 6 days later than trees that had not been whitewashed. Other trees at the same station, when shaded from the sun during the winter with boards, produced a full crop of buds, while 80 per cent of the buds on exposed trees were killed. This latter method of winter protection is too expensive except on a small scale.

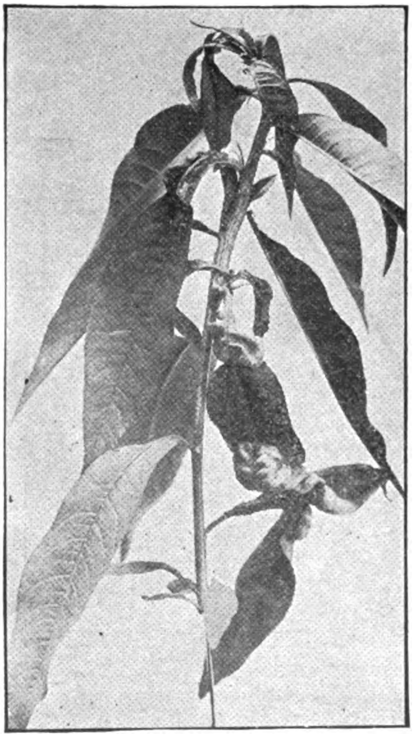


Fig. 285—PEACH LEAF CURL
(Cornell Expt. Sta. Bul. 164)

The effect of whitewash on peach trees is shown in Fig. 284.

Buds that cannot be saved when the trees are left in an upright position, can often be saved by laying the tree down and covering with hay, cornstalks, earth, and like material. When this method is practiced the roots on the north and south sides of the trees are cut to secure a lateral development and the tree bent over. In bending down the top the side roots should be slightly twisted to prevent them from breaking. The injury to the tree is slight and a crop of peaches is practically assured. Trees may also be protected on a small scale by tying cornstalks around the tops of trunks in the fall. Details for laying down peaches in Colorado may be found in Colo. Expt. Sta. Bul. 80.

Varieties—As with other orchard fruits there is a large number of varieties of peaches—some early, some late, some with white flesh, others with yellow flesh, some in which the flesh is attached to the pits and are known as "clings" and others in which the pits are free and known as "free-stones." This article cannot do more than indicate a few of the more popular varieties in different peach districts. In Michigan Hale, Lewis, St. John, Richmond, Barnard, Jacques, Gold Drop, Late Barnard, Hill Chili and Smock are given by the station as the 10 most popular sorts. These varieties are described in the station bulletins, copies of which can probably be obtained by request to the director. In New Jersey the experiment station states that Crawford Late, Mountain Rose, Old Mixon, Stump and Reeves Favorite are most generally grown. (N. J. Expt. Sta. Bul. 133.) In Texas the following varieties are recommended for the whole state: *Early*—Alexander, Mamie Ross, Tillotson; *Medium*—Spottswood, Elberta and Gen. Lee; *Late*—Stonewall Jackson, Columbia and Texas.

In Missouri the best varieties in order of ripening are Southern Early, Mountain Rose, St. John, Reeves Favorite, Champion, Elberta, Old Mixon, Crawford Late, Stump and Smock. For California: Crawford Early, Foster, Seller Golden Cling, Smock, etc.

Experiment Station Literature—The following are some of the more important bulletins published by the experiment stations on peach culture: Ariz. Expt. Sta. Bul. 37; Ark. Expt. Sta. Bul. 79; Canada Central Expt. Farm Bul. 1 (2nd ser.); Colo. Expt. Sta. Bul. 80; Del. Expt. Sta. Buls. 54 and 62; Fla. Expt. Sta. Bul. 62; Ga. Expt. Sta. Bul. 42; Md. Expt. Sta. Bul. 72; Mich. Expt. Sta. Bul. 103; Mo. Expt. Sta. Buls. 38 and 55; N. J. Expt. Sta. Bul. 133; N. Y. Cornell Expt. Sta. Bul. 74; Pa. Expt. Sta. Bul. 37; Tex. Expt. Sta. Buls. 39 and 58; W. Va. Expt. Sta. Bul. 82; U. S. Dept. Agr. Farmers' Bul. 33.

Enemies: LEAF CURL (*Exoascus deformans*) (Fig. 285) affects the leaves, twigs, flowers and fruit and is most injurious in humid places and in wet seasons. The leaves become curled, thickened, yellow, and finally fall. The fruit is affected in the same manner. A second crop of leaves develops to a greater or less extent, according to the soil and climatic conditions. Twigs are often distorted and sometimes the trees are killed outright. The disease occurs wherever peaches are grown. Many fungicides have been tried for this trouble, but the best results are obtained by spraying with Bordeaux mixture (5-5-45 formula—see *Spraying*). Two or three applications should be made a few weeks before the time of flowering. It is best to spray in dry calm weather, during the middle of the day. In many localities a single application in winter is sufficient.

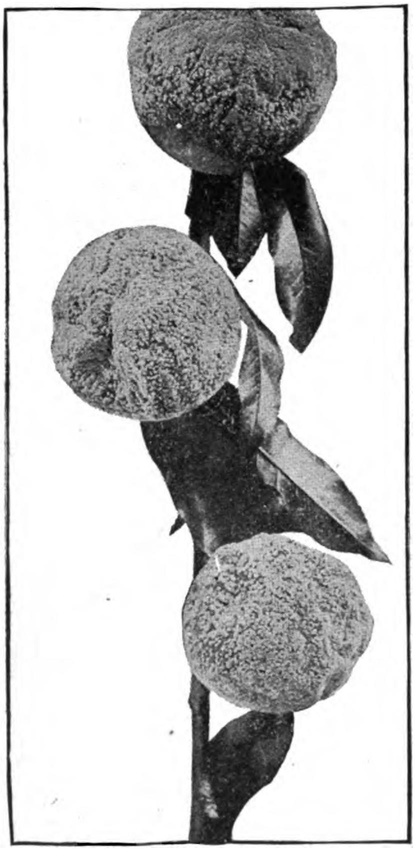
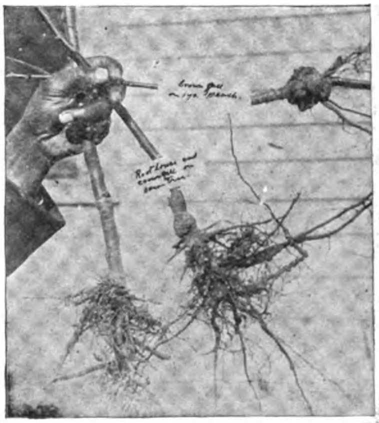


Fig. 286—PEACH ROT
(Ga. Expt. Sta. Bul. 50)

Brown Rot (*Monilia fructigena*) (Fig. 286) attacks peaches, apples, cherries and plums, and is one of the most serious diseases of these fruits. It is especially injurious to early varieties of peaches, causing them to rot at the time of ripening. It is first seen in peaches which are in contact with each other and spreads most rapidly in moist, warm weather. Diseased fruit turns brown, dries up, and becomes covered with a gray fungous coating. The young twigs may also be attacked and killed. The dried or "mummy" peaches may remain on the trees over winter. Such fruit should be removed and destroyed as soon as observed. Trees should be sprayed when buds are swelling with Bordeaux mixture (4-4-50 formula) and again just after the calyx falls with the same fungicide (2-2-50 formula).

Scab or Black Spot (*Cladosporium carpophilum*) attacks late varieties most severely. It appears as small black spots on the side of the peach, and when the spots are numerous they run together and the fruit cracks open. Spray with Bordeaux mixture, beginning about the first of July. Use a weak solution. A few treatments may be necessary in August. For this purpose the ammoniacal solution of copper carbonate may be used.

Brown Spot (*Helminthosporium carpophilum*) begins on the green fruit but is most conspicuous on ripe fruit, where it appears as pink spots containing a brown area. At first the spots are elevated. Finally the spots run together and become a uniform brown patch on the upper surface of the fruit. The same fungus may cause knots on the young twigs. The disease may be controlled by spraying with weak Bordeaux mixture after the calyx falls and again about 2 weeks later.


Crown gall on 1 yr. peach
Root louse and crown gall on same tree
Fig. 287—CROWN GALL ON ONE-YEAR PEACH
Root louse and crown gall on same tree
(Ark. Expt. Sta. Bul. 71)

Shot Hole (*Cercospora Persica*) appears as red circular spots on the nearly full grown leaves. The diseased tissue falls out, leaving small holes. Treatment is the same as for brown rot.

Rust—See under *Plum.*

Powdery Mildew—See under *Apple.*

Crown Gall—See under *Apple.* Affected peach roots are seen in Fig. 287.

Peaches are also affected by stem blight, anthracnose, root rot, knot disease, "little peach," etc., due to parasitic fungi, but not usually of a very serious nature.

Yellows is one of the most important of peach diseases and is to be recognized by the premature ripening and high coloration of the fruit, which is spotted with red in the flesh. New buds develop on the trunk and branches, and the winter buds frequently unfold in the fall. The fruit ripens prematurely and shows conspicuous red spots from skin to pit. Diseased trees sometimes bloom late in the fall. (Fig. 288.)

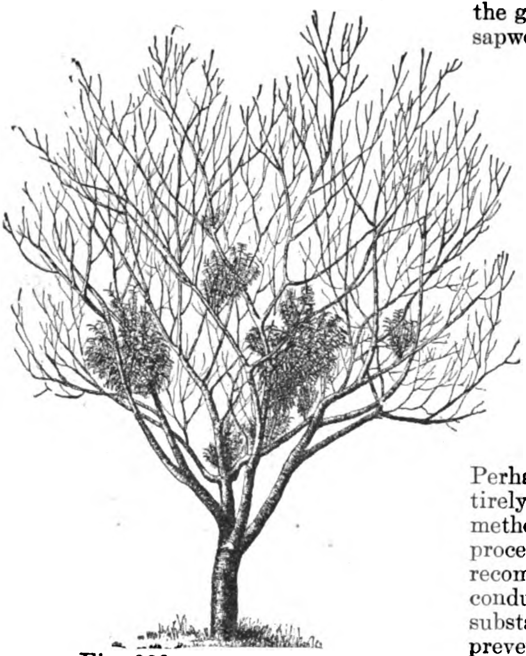


Fig. 288—PEACH YELLOWS
(U.S. Dept. Agr.)

A yellow color on the foliage is not confined to cases of this disease. The cause of yellows is not understood. It is apparently contagious and its spread should be prevented by the immediate removal and burning of all affected trees. Fungicides and fertilizers have thus far proved of no avail.

Rosette is a contagious disease mostly confined to the Southern States. The cause is unknown. It appears in the spring and affected trees die during the following fall or winter. The leaf buds do not elongate but grow in compact tufts 2 or 3 inches in length. The outer leaves of the rosettes are long, straight, and turn yellow and fall off prematurely. No remedy is known and the only means of prevention is the destruction of all diseased trees.

Borer (*Sannina exitiosa*) is a slender blue moth, which resembles a wasp. (Fig. 289.) The eggs are laid in the wood of peach, apple, plum and cherry, near the ground. The young larvae bore in the sapwood and cause an exudation of gum from the holes in the bark. The insect lives 1 year in the wood, at the end of which time it reappears as a moth. Numerous remedies have been recommended for the destruction of this insect. A large number of them are dangerous to the trees and still others are practically useless. According to recent experiments in New York, the most effective remedies are mounding or throwing up earth around the trunks of the trees, the use of tarred paper or tobacco stems about the trunks of the trees, digging out the larvae, and an application of gas tar. Perhaps no single remedy will prove entirely effective, but a combination of methods including the digging out process and 1 other effective remedy, is recommended. In some experiments conducted in New Jersey, a number of substances were tested for their value in preventing the borers from entering the trunks of the trees. These substances included newspapers, tarred paper, heavy wax paper, tile protectors, wire netting, hydraulic cement, and Bordeaux mixture with an excess of lime. Considerable success is reported from the use of a continuous coating of hydraulic cement mixed with skimmilk and applied to the trunks of the tree. Good results have also been obtained from wrapping trees with a double thickness of newspapers to a hight of 50 inches or more above the ground.

Twig Borer (*Anarsia lineatella*) is a moth with gray forewings, marked with brownish-black. The hind wings are of a darker color. The caterpillar is nearly transparent and pink in color. This insect destroys the terminal and sometimes the lateral leaf buds by eating them off at the base from its burrows in the twigs. Infested twigs usually do not fall off, although completely severed, but are held in place by a gummy substance. All infested twigs should be removed and burned.

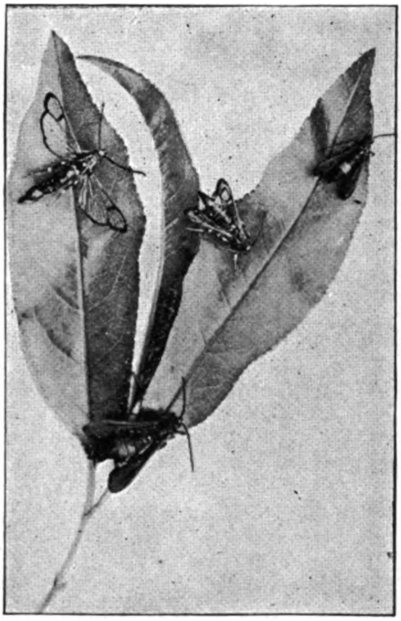


Fig. 289—MOTH OF PEACH BORER
(Cornell Expt. Sta. Bul. 176)

Scale Insects and Mealy Bugs—These terms are commonly used to denote the various insects which are included under the term *Coccidae,* including *Aleurodes.* The family includes a considerable number of species which differ greatly in appearance and habits. The sexes of these insects are totally unlike, the males having 2 wings and the females being wingless, grub-like creatures, of a small size. The body of the adult female is usually scale-like or gall-like in form and is covered with a waxy or powdery secretion. The armored bark lice include a number of so-called scale insects which are protected by a shield-like cover. The shield or scale is partly secreted by the body and partly formed by the plant tissues. It finally becomes more or less completely separated from the body, covering the whole insect and in the case of the female the eggs also. Another sub-family of scale insects are known as naked bark lice, from the fact that in this group no separable scale or covering is secreted by the insect. The female lays her eggs upon the bark and the young crawl about for a short time, after which they attach themselves to the bark by inserting the beak, and remain in this position. In the armored insects the secretion of the scale begins as soon as the young lice become fixed in position. The young lice are therefore unprotected only during a short period of their existence. The term mealy bug is used to denote a number of insects belonging to the same general group, which are characterized especially by the development of a powdery or hairy secretion on the body and wings.

Scale insects attack all kinds of plants, including grasses, but are especially injurious to fruit trees. The more common injurious species in the United States are San Jose scale, oyster-shell bark louse, scurfy scale, greedy scale, English walnut scale, peach scale, peach lecanium, New York plum scale, cottony cushion scale (Fig. 290), Florida wax scale, Putnam scale, imported elm bark louse, purple scale, white scale, red scale of California, chaff scale, orange chionaspis, black scale, barnacle scale, mealy bugs, cottony maple scale, etc.

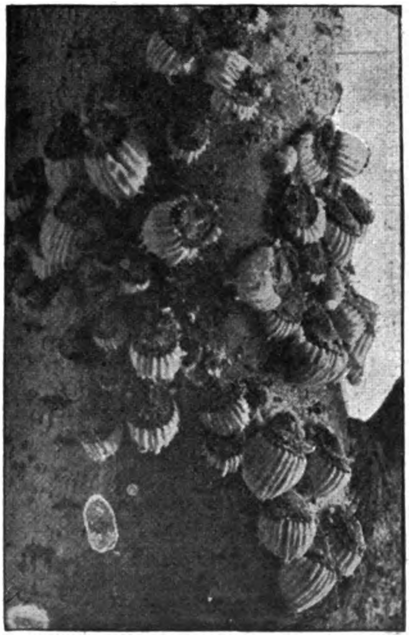


Fig. 290—COTTONY CUSHION SCALE
(Fla. Expt. Sta. Bul. 56)

Scale insects are subject to attacks of a number of natural enemies, included under parasitic and predaceous insects, fungous diseases and birds. These natural enemies are usually sufficient to hold the species somewhat in check, with the exception of certain ones such as the San Jose scale, which has become one of the most important of orchard insects.

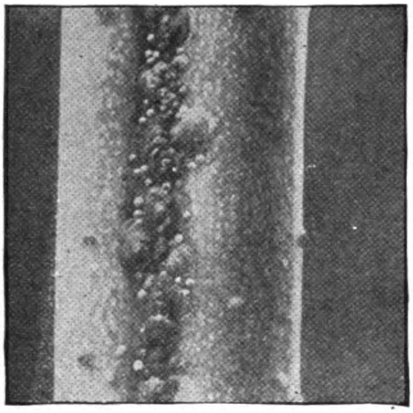


Fig. 291—SAN JOSE SCALE ON PEACH TWIG
(From Conn. State Expt. Sta. Bul. 135)

The artificial remedies which have proved most successful in combating scale insects are fumigation with hydrocyanic-acid gas, spraying with crude petroleum or kerosene either undiluted or mixed with water, spraying with various soap solutions and with lime, salt and sulphur wash. The last named insecticide is popular in California and all States infested with San Jose scale. All scale insects may be treated by the same method after it has been determined by experience which process is most effective in any particular locality.

The most extensive experiments with remedies have been made in combating the San Jose scale. A peach twig infested by San Jose scale is seen in Fig. 291 and the scale on plums in Fig. 292. The results obtained from these experiments are usually applicable to other scale insects. The scale of the female San Jose scale is nearly circular in outline and somewhat larger than that of the male. The scale of the male is nearly twice as long as wide and is darker than that of the female, being sometimes black. The female scale is gray, with the exception of a central area which varies from pale to reddish yellow. The scales are of a small size, being about 1-10 of an inch in diameter. In the Eastern States the best success has attended the use of resin wash and the lime, salt and sulphur wash, which are also very effective on the Western coast. The most convenient and successful method for treating nursery stock and small fruit trees, where the expense is not too great, is by fumigation with hydrocyanic-acid gas. This same method has also been tested on a large scale in orchards, first in California and later in the Eastern States. When this method is thoroughly applied, all scales are destroyed and there is little danger of injury to the trees. Recently crude petroleum undiluted or mixed with water, and kerosene pure or mixed with water, have been extensively used in spraying for the destruction of scale insects. Different results have been obtained by different experimenters, but extensive experiments which have been carried out at the New Jersey Experiment Station indicate that kerosene and crude petroleum are reliable and exceedingly effective insecticides against scale insects. The results obtained at the New Jersey Station have been further substantiated by experiments in other States, and it is generally recommended as a safe and effective remedy against San Jose scale that trees should be sprayed in winter or during a dormant period with these substances in undiluted condition or in mechanical mixture with water produced by special machines made for this purpose. The method is recommended as harmless when applied to the hardy varieties of apples and pears in winter, but in some localities trees have been injured by spraying with petroleum or kerosene in

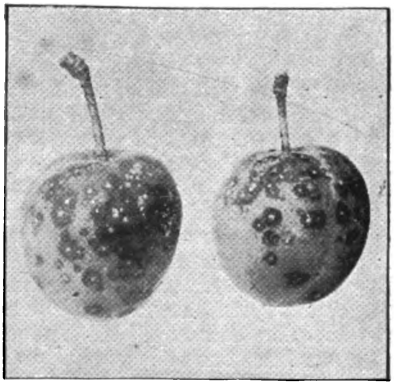


Fig. 292—SAN JOSE SCALE ON PLUMS
(From Conn. State Expt. Sta. Bul. 135)

the undiluted form even in winter. On the other hand many experiments have been made which show that these substances in solutions of strengths varying from 15 to 20 per cent, may be safely sprayed upon the trees in full foliage. The conservative authorities on the subject of the value of kerosene and petroleum recommend that these substances should be used only in a mechanical mixture with water of different strengths up to about 25 per cent. Where the expense of operating the fumigating outfit is considered too great, perhaps the next best method for treating the San Jose scale consists in the use of the lime, salt, sulphur wash, as just indicated. In general it is recommended that spraying with kerosene should be done only on bright sunshiny days, when evaporation is comparatively rapid. Whale-oil soap in the proportion of 2 or 2½ pounds to the gallon of water is also a very effective remedy for scale insects.

NEMATODES—Nematode is the name applied to a large group of round worms, most of which are parasitic in animals or plants. A group of nematodes known as eel worms is of considerable economic importance, on account of the habits of this family in attacking the roots of various plants, causing the formation of knots or galls. These nematodes vary considerably in size, but as a rule are exceedingly slender and tapering at either end. A considerable variety of eel worms have been observed injuring cultivated plants in different countries, but in the United States 1 species, *Heterodera radicicola,* is the most injurious. Plants attacked by this species are covered with swellings or galls on the roots. The swellings are sometimes spherical, but vary exceedingly in size and are often irregular in shape. These galls occur on a great variety of plants, including garden vegetables, greenhouse plants, and fruit and shade trees. In badly infested soil plants may be killed outright. Tomato and cucumber seedlings often suffer severely from the attacks of eel worms. Eel worms are not the only cause of swellings on the roots of cultivated plants. For a discussion of clubroot of cabbage see under *Cabbage.* The small tubercles which are found on the roots of various legumes are usually due to a bacterial organism which is concerned in the fixing of free nitrogen. The root tubercles produced by the woolly aphis may usually be recognized by the presence of the aphis. For crown gall, which is caused by a fungous parasite, see under *Apple.* In galls produced by nematode worms, an examination of the internal structure reveals the presence at least of female worms.

The young worms in coming into soil from affected plants, search for suitable roots to attack. They force their way into the root and thus set up an irritation which causes an abnormal growth of the root tissue. The worm increases in length and takes on a spindle and later a club shape. The females are larger and become readily visible to the naked eye. Various chemical insecticides have been tried in combating the attacks of these worms, but without striking success. Solutions of the insecticide capable of killing the adult worms are usually injurious to the infested plants. In greenhouses the most successful method of combating eel worms consists in heating the soil by means of steam or otherwise, to a temperature of 180° to 212° F. A temperature of 140° F. will kill the nematodes, but higher temperatures should be used in order to be certain that all the worms are destroyed. The various species of *Heterodera* which are especially injurious to garden vegetables and greenhouse plants are rather susceptible to the influence of extreme cold and are usually unable to survive the severe winters.

In the case of knot disease of fruit and shade trees, caused by eel worms, proper drainage of the soil, rotation of crops, and burning all stumps and infested roots which may have been removed from the soil, is usually sufficient to protect the crops against the serious attacks of nematodes. In combating the nematode worms which attack coffee and similar crops in tropical countries, the use of the remedies already mentioned and bisulphid of carbon injected into the soil, have given fairly satisfactory results.

CURCULIO—See under *Plum.*

The peach is also attacked by tent caterpillars (see under *Apple*), and many other species of minor importance.

PEAR (*Pyrus communis*)

This orchard fruit is grown over a wide range of country but is most successful in the New England and the Eastern States, and as far west as Michigan. It thrives especially well also on the Pacific slope. In many of the Southern States and much of the interior it is seriously injured by blight. Much of the Northwest is too cold for pears except for a few Russian sorts of inferior quality.

Propagation—Standard pear trees are usually grown on seedling pear stocks budded in July or August. The trees are set in the orchard 1 or 2 years from the time the buds are put in. (See *Grafting.*) Dwarf trees are produced by growing standard pears on quince roots.

Soil—Pears are successful on much heavier lands than peaches and apples can be grown on. They do best on rather stiff clay loams or even hard clays when they are well drained. Many successful orchards are also located on the lighter loams or sandy soils, but in such situations the trees tend to make too rapid and immature growth, are more subject to diseases and winterkilling, and the orchards are short lived. On alkali soils pears will grow where barley will.

Planting—The pear orchard should be well prepared by deep plowing and thorough cultivation. Standard trees are set 18 to 22 feet apart each way and dwarfs 12 to 16 feet apart. The pear orchard should be plowed each spring and kept cultivated until the last of July or first of August. While the trees are young certain crops like potatoes, melons, cabbages, peas, beans, etc., may be planted between the rows; but cereals should not be grown, nor tall growing plants like corn, nor should the orchard be seeded down. The intercultural crop should be more and more restricted to the center of the rows each year and at the end of 5 years the whole space should be given entirely to the pears. From the first no crop should be grown closer than 4 feet from the trees and the trees given good cultivation.

With dwarf trees the spring plowing should always be made toward the trees. The quince stock enjoys a more moist soil than pear stock. With standard pears it will do no harm to plow away from the trees occasionally in order to keep the ground more level. The pear makes most of its wood growth before mid-season and cultivation should be most thorough at this time. Later in the season cover crops may be grown, if the land needs bringing up, or the orchard left to take care of itself.

On fairly fertile soils pears do not require fertilizers until they come into bearing. After that phosphoric acid and potash are most essential. Nitrogenous fertilizers should be used only in limited amounts. A leguminous cover crop turned under is safer than the application of barnyard manure. The nitrogenous fertilizers tend to wood growth and disease and should be used sparingly unless the trees are making a slow, weak growth. A good mixture recommended by the New Jersey Station for pears consists of 100 pounds each of ground bone, muriate of potash and acid phosphate per acre or 150 pounds of ground bone and 100 pounds of muriate of potash. Unleached wood ashes are very valuable, and on many soils the addition of lime is essential. Many growers use barnyard manure, wood ashes and ground bone for pears with very good results.

Pruning—Pear trees should be headed out 16 to 18 inches from the ground. Pruning to a vase form, while requiring more skill in the beginning, produces trees easy to work around and to prune, thin and harvest the fruit. The head should be started with 3 main branches coming out from different places on the trunk. Standard trees should be continually headed back to about 18 inches of annual growth. The tree naturally grows in a pyramidal form and when thus grown requires little pruning other than an annual thinning out. Winter and early spring is the usual period for pruning pears. The fruit of the pear is borne on spurs which continue to branch and fruit for several years.

Thinning—Pears are thinned perhaps more than any other fruit. This practice prevents the trees from overbearing, improves the quality, size and marketableness of the fruit and tends to the production of annual crops. It pays. The fruits should not be left closer than 6 inches apart. Of course all wormy and inferior fruit is thinned out first.

Harvesting—Unlike most fruits the pear is improved in quality by picking some time before it is ripe and then ripened up in a close room or packed in boxes and allowed to ripen. They should be picked by hand. When the pears have reached full size and a very slight color begins to show they should be gathered. They mellow and color up beautifully in storage, but should not be kept where the air will blow over them or they shrivel up more or less. Pears are usually packed for market direct from the tree. They keep best in cold storage at a temperature of 32° F. From 80 to 100 barrels of pears per acre is a fair yield. The life of a standard orchard varies from 25 to 50 years and of a dwarf orchard somewhat less.

Varieties — The leading commercial pears in this country are Kieffer and Bartlett. The Kieffer is one of the varieties that can be most successfully grown in the South. It is a vigorous, productive tree and the fruit is of excellent keeping quality. The Bartlett is widely grown in the East and is the chief variety grown in California. The Seckel is a prominent Eastern variety and a standard as regards quality. Different varieties of pears mature from midsummer to late winter. Good summer ripening varieties are Osband Summer, Bartlett, Clapp and Manning Elizabeth; fall varieties, Duchess, Flemish Beauty, Bosc, Louise Bonne, Seckel and Sheldon; for winter, Anjou, Clairgeau, Lawrence and Winter Nelis.

Sterility of Pears—Investigations of recent years have shown that many varieties of pears are self-sterile to their own pollen (see *Sterility of Plants*), and will produce no fruit, or only inferior crops, unless cross-fertilized with the pollen of other varieties. Among these are Angouleme, Anjou, Bartlett, Clairgeau, Idaho, Kieffer, Nelis, Clapp Favorite, Doyenne, Easter, Louise Bonne, Howell, Jones, Lawrence, Mount Vernon, Pound, Sheldon, Colonel Wilder, etc. None of these varieties should ever be planted in large blocks alone. It is probable that almost any variety will pollenize nearly any other variety. In the orchard not more than 2 rows of 1 variety should ever be planted together, and it is advisable that every row be alternated with a different variety to insure a good set of fruit.

Dwarf Pears—Pears grown on quince roots are much dwarfed in size. They come into bearing much earlier than standard trees, are very productive and the quality of such varieties as Angouleme is greatly improved. Dwarf trees require more pruning than standards and should not be grown higher than 12 feet. According to Bailey, from ½ to 2-3 of the annual growth should be pruned back each season late in the winter. In setting the trees in the orchard the point of union should be 5 or 6 inches below the surface of the ground. This places the quince roots beyond the reach of borers. The following varieties are oftenest grown as dwarfs: Duchess, Louise Bonne, Anjou, Clairgeau, Manning Elizabeth, Bartlett, Seckel and sometimes Kieffer. Some of the more useful bulletins on pear culture are as follows: N. J. Expt. Sta. Bul. 142; Va. Expt. Sta. Bul. 49; U. S. Dept. Agr. Yearbook 1900, p. 369. A successful dwarf pear orchard is shown in Fig. 293.

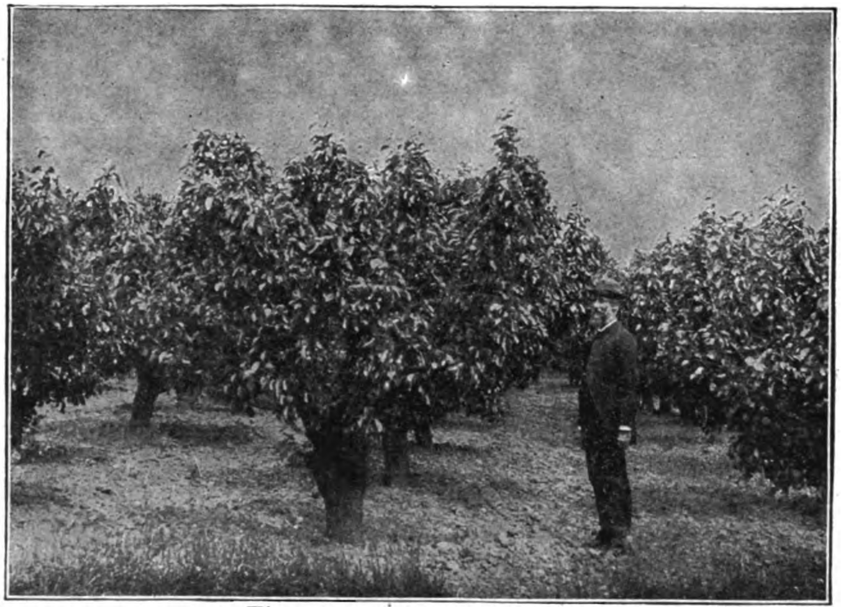


Fig. 293—DWARF PEAR ORCHARD
(From Yearbook U. S. Dept. Agr. 1900)

Enemies: FIRE BLIGHT (*Bacillus amylovorus*) appears in the spring on the blossoms. Some flower clusters turn black and the disease is carried from flower to flower by bees and other insects. From the flowers the disease spreads to the leaves and twigs. The leaves turn to a uniform brown color and sunken areas appear on the twigs. "Blossom blight" and "twig blight" are different forms of the same disease. The only treatment for this trouble is of a preventive nature. Trees should be kept in good, vigorous condition by cultivation and fertilization and all blighted parts should be cut out as soon as observed.

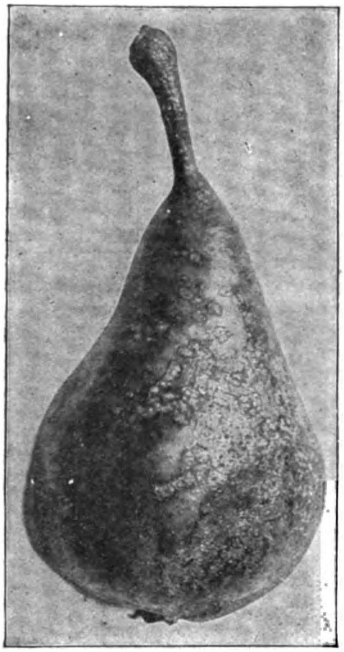


Fig. 294—PEAR INJURED BY LEAF BLIGHT FUNGUS

(From N. Y. Cornell Expt. Sta. Bul. 145)

Leaf Blight (*Entomosporium maculatum*) attacks pears and quinces, affecting the fruit, stems and leaves. The disease appears with the first appearance of the leaves, or later, if the season is dry. Small brown spots appear on the leaves, increase in size and finally run together. The leaves fall prematurely. On the fruit the spots are red, and later turn black. The quince is affected in the same way, except that the leaves may turn yellow before falling. The Duchess and Kieffer varieties are somewhat resistant. In orchards the disease may be controlled by several applications of Bordeaux mixture, beginning when the leaves are nearly full grown. A pear injured by leaf blight is seen in Fig. 294.

Scab (*Fusicladium pirinum*) appears as brown spots on the leaves or fruit. Affected fruit usually cracks open. The disease is very similar to apple scab and may be checked by spraying with Bordeaux mixture before flowering, after the blossoms fall, and a third time about 2 weeks later. A specimen of badly infested pear is seen in Fig. 295.

Leaf Spot (*Septoria piricola*) closely resembles leaf blight, but the spots are larger and more distinct. The center of the spots is gray, with minute black specks. The gray shades into brown and purple on the edge of the spots. The disease may be held in check by 3 applications of Bordeaux mixture at intervals of 2 weeks, beginning just after the petals fall.

Canker—See under *Apple.* A canker infested pear tree is seen in Fig. 296.

Sunscald—See under *Apple.*

Blister Mite (*Phytoptus pyri*) is a small mite barely visible to the naked eye, of a white color. The eggs are deposited in spring and the mites on hatching make their way to the young leaves, where they cause the forma-

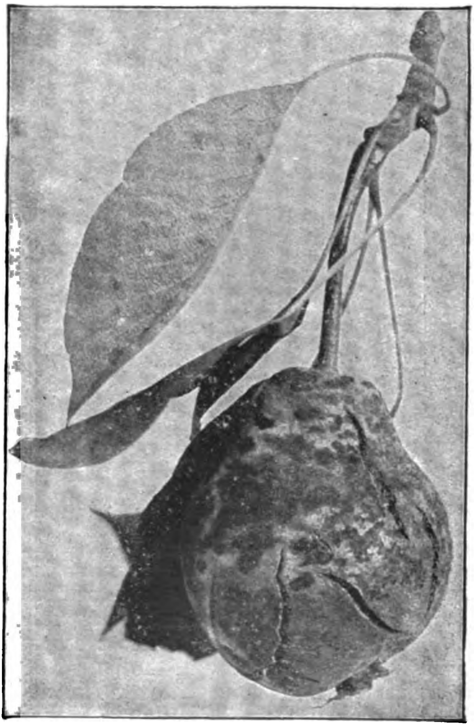


Fig. 295—SUMMER DOYENNE BADLY INJURED BY PEAR SCAB

(From N. Y. Cornell Expt. Sta. Bul. 145)

tion of galls, in which they live during the summer. In the fall the mites leave these galls and migrate to the winter buds, in the scales of which they pass the winter. Infested leaves show red spots or blisters, which change to green and later to a brown color. Such leaves should be removed and destroyed, and the trees should be sprayed in winter with kerosene or kerosene emulsion. This treatment destroys the mites in the bud scales.

Midge (*Diplosis pyrivora*) is a fly resembling the mosquito, which appears just before the flowering time, pierces the flower buds and lays its eggs on the stamens. The maggots on hatching penetrate into the core of the young pear. The maggots become mature in June and drop from the deformed pears to the ground. The winter is passed in the chrysalis stage. Infested pears have a knotty, irregular shape and drop from the trees prematurely. The Lawrence and Bartlett are most attacked. The ground underneath pear trees should be thoroughly cultivated and rolled not later than the last week in May, and kainit should be applied at the rate of 1000 pounds per acre, for the purpose of destroying the chrysalis in the soil.

Psylla (*P. pyricola*) is a minute insect resembling a cicada in appearance. The immature form is of a yellowish color and the adult is nearly black. The adults of the first brood appear about June 1, and those of the second brood about 1 month later. The immature form of the insect may be readily killed by spraying with kerosene emulsion in early spring, just after the leaves have unfolded.

Borer (*Sesia pyri*) is a moth resembling a peach tree borer and often mistaken for a wasp. The eggs are laid upon the bark of the trunk or lower branches, and the larva makes its way into the sapwood, where it lives for about 1 year. Warts or black swellings appear upon infested branches, and sometimes several larvae may be found in a single swelling The larvae may be dug out with a knife, while the swellings may be treated with kerosene.

Fruit Tree Bark Beetle (*Scolytus rugulosus*) is a small cylindrical beetle, 1-10 of an inch long, black in color, which emerges in March and eats small holes through the bark. After penetrating through the wood, burrows are made lengthwise of the tree, and in these tunnels the eggs are deposited and the young grubs form small tunnels at right angles to the original ones. There are 4 or more generations annually, and the beetle feeds on all the common deciduous fruit trees. Trees should be kept in vigorous condition in order to withstand the attacks of this beetle. A wash containing 1 pound of potash whale-oil soap to 2 gallons of water, applied in March and again in April, will prevent some of the beetles from boring into the trees. Similar results may be obtained by spraying the trunks and branches with kerosene emulsion, Bordeaux mixture and Paris green, or whitewash. Badly infested trees should be removed and burned in winter.

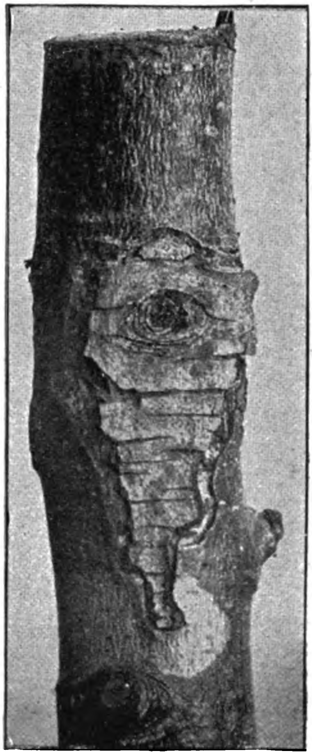


Fig. 296—PEAR CANKER
(From Del. Expt. Sta. Bul. 52)

Twig Girdler (*Oncideres cingulatus*) is a brown or gray beetle, ½ inch in length, with long antennae. There is a conspicuous gray band on the back. Eggs are deposited in the fall near the end of twigs below each bud. The twig is then girdled between the egg and the trunk. Such twigs fall off and the larvae continue to develop in them. Fallen twigs should be collected and burned before the insects escape. No other practical remedy has been devised. The insect attacks various other fruit trees as well as the pear.

SINUATE BORER (*Agrilus sinuatus*) is a beetle 1-3 of an inch long, of a bronzed brown color. The eggs are laid in June on trunks and branches, especially on trees with smooth bark. The grubs bore downward into the sapwood and the burrows are zigzag in their course. The branches are sometimes completely girdled by these burrows and die. Badly infested young trees should be removed and burned. The bark may be covered from May to July with a clay paste for the purpose of preventing the beetles from escaping.

CIGAR CASE BEARER (*Coleophora Fletcherella*) is a small moth of a gray color, with fringed wings. The eggs are deposited in June and July on young branches or leaves. The caterpillars burrow into the leaves, where they remain for 2 or 3 weeks, at the end of which time they leave the tunnels and construct cases by tying pieces of leaves together. They feed during the fall upon the leaves, remaining in the cases. The winter is passed in this condition and the larvae feed upon the open buds in the spring. The caterpillars may be destroyed by spraying with Paris green as soon as the cases are seen on the opening buds. A second or third application should be made at intervals of from 4 to 7 days. Kerosene emulsion is also effective for this purpose.

APHIS—See *Plant Lice* under *Cabbage.*

SCURFY SCALE—See *Scale Insects* under *Peach.*

SLUG—See under *Cherry.*

CURCULIO—See under *Plum.*

BORERS, BUD MOTH and CODLING MOTH —See under *Apple.*

PECAN (*Hicoria pecan*)

This nut tree belongs to the hickory genus. It grows wild in rich river bottoms from Iowa and Kentucky south to Louisiana and west into Texas. It is probably the most important native nut tree in America. Most of the pecans of commerce are gathered from wild trees, but commercial pecan orchards are being planted in many Southern, Central and Southwestern States and California. The trees when grown from nuts from the northern limits of the pecan belt are hardy as far north as Michigan and Massachusetts. The pecan tree when fully matured is one of the monarchs of the forest. It grows from 90 to 175 feet high and has a majestic dome-like top. In leaf appearance it resembles the common shagbark hickory. The nuts are generally oblong in shape and vary in size from 25 to 100 nuts per pound.

Propagation—The tree is propagated from seed. The nuts may be either stratified in moist sand in the fall and planted out in the spring or planted out in the fall soon after they are gathered. The latter is the better method unless mice and other rodents are too abundant. The nuts should be planted 3 inches deep in well-prepared nursery soil, placing the nuts side down and about 3 inches apart in rows 2½ feet apart. During the growing season they should receive the same fertilizers and cultivation as are usually given to orchard trees. The trees will be ready to set in the permanent orchard in 2 years. When the trees are grown from seed only about 50 per cent come true to the parent form. Many growers are therefore budding or grafting the improved varieties on seedling stocks. As with all the hickories, this is a rather difficult process. Annular and veneer shield budding or cleft and whip grafting (see *Grafting*) have proved the most desirable methods of budding and grafting these trees so far. The graft should be made at the crown and close down to the ground. If the stock is small enough the whip graft should be employed, but if 2 or 3 inches in diameter a side cleft graft is better. The cion should have 3 buds, and preferably a terminal one. The graft should be held in place by pressing moist clay about it or with grafting wax. Dirt should then be drawn up around it. Grafted or budded stock should remain 1 year longer in the nursery than seedling stock.

Soil—On very rich soils pecan trees tend to grow wood rather than nuts. One writer in Georgia states that sandy loam soil with a clay subsoil has given excellent results with him. In general land suited to the culture of corn and cotton will give good results with pecans.

Planting—The trees in the orchard should stand about 40 feet apart on the poorer soils and 50 to 60 on the richer bottom lands. The pecan has a very long tap root. At transplanting time this should be shortened back to about 18 inches from the crown and all injured roots removed. The Florida Station recommends root pruning in the nursery row. This practice it is thought favors the development of more lateral roots. Pruning the tops of 1 and 2-year-old trees set in the orchard is not considered advisable, as it tends to the development of shoots. The pruning necessary for the pecan is confined largely to the formation of the head. This should be started 3 or 4 feet from the ground and the center limbs cut back to induce lateral branches and a rounded form. The pecan orchard will require about the same cultivation as fruit orchards. Pecan trees may bear a few nuts at an early age, but paying crops cannot be expected under 10 years and full crops under 20.

Varieties—By selection and cultivation a number of varieties of pecans have been originated which are great improvements over the native sorts. Thin shelled varieties, other factors being equal, are most desirable. Frotscher is one of the largest and best pecans and has a thin shell. Century is one of the largest varieties, the nuts running about 25 to the pound. Other excellent sorts are Stuart, Van Deman, Paragon, etc. Prominent types of pecan forms are seen in Fig. 297. Native trees that produce inferior nuts have been successfully top-grafted with improved varieties in the Gulf States. The Florida Experiment Station has published a bulletin, No. 57, giving concise directions regarding this subject.

Uses—The bulk of the commercial pecan crop is now obtained from native forests in Texas, Louisiana and Mississippi. The nuts retail in the market from 20 to 75 cents per pound. They are used for dessert as other nuts are, and in confectionery. See also Fla. Expt. Sta. Bul. 54; U. S. Dept. Agr. Bureau Plant Industry Bul. 30.

For enemies see under *Hickory*.

PERSIMMON

The native persimmon (*Diospyros Virginiana*) grows wild in nearly all the Southern States and as far north as Rhode Island and the Great Lakes. The Japanese persimmon (*D. kaki*) or kaki has been successfully grown as far north as Tennessee, but the larger commercial orchards of this species are located in Florida, Texas and California.

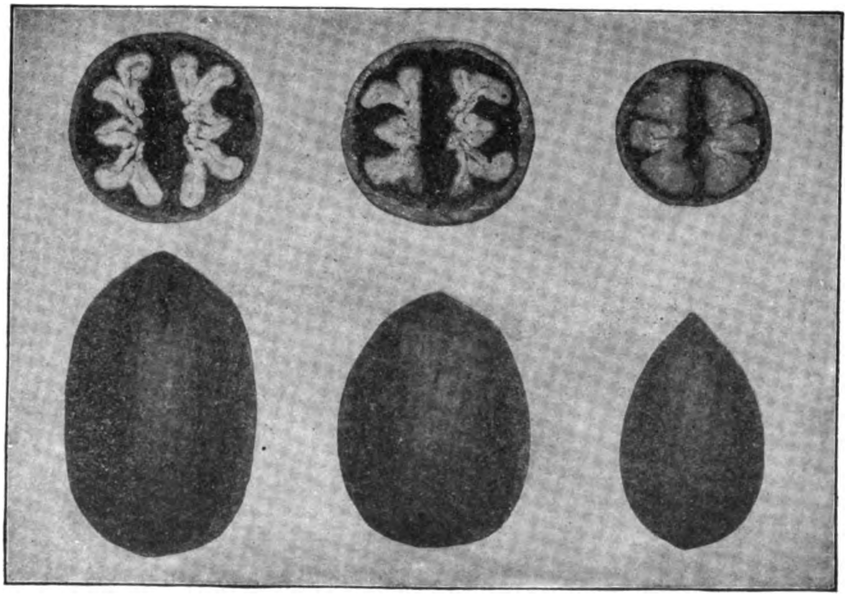


Fig. 297—PECAN NUTS
(From Yearbook U. S. Dept. Agr. 1899)

The native tree sometimes attains a hight of 60 feet, with a trunk diameter of 2 to 3 feet, but is usually less than 40 feet high. It is little cultivated. The green or partly ripe fruit is very puckery to the taste, but loses much of this on ripening, becoming sugary and very edible. It varies from ½ to 2 inches in diameter and assumes various forms, but in general resembles a crab apple. Each fruit usually contains from 4 to 8 rather large flat seeds. Some varieties are nearly seedless. The fruit ripens from August to December. Frost seems to aid in the ripening of some varieties, while others mature before frost comes.

Propagation—Some attention is being paid to the culture of native persimmons. They are usually propagated from seed. The seedlings do not come true to the parent type, however, any more than apple seed do, and budding and grafting the seedlings with improved varieties is therefore resorted to. The seed is stratified in moist sand over winter and planted out in the spring. The seedlings remain in the nursery 1 or 2 years and are budded or crown grafted in the spring, when the bark slips freely. Transplanting is best done in autumn. As much of the tap root should be preserved as possible, otherwise the tree is very difficult to transplant successfully. It thrives best on soil suited to the plum or peach. Valuable orchards can often be quickly grown by top-working old native trees with improved varieties. In this work the cions must be inserted in vigorous growing branches. It is claimed that the persimmon is as easily grafted as the apple. An improved tree will yield from 2 to 3 bushels of fruit annually. Some of the more important native varieties that have arisen are Kemper, Daniel Boone, Shoto (a plate of which, much reduced in size, is shown in Fig. 298), Early Bearing, Golden Gem, etc.

Japanese Persimmons—The Japanese persimmon has been grown in this country only about 25 years. The fruit is much larger and more attractive in appearance than the native persimmon. The trees are smaller and the same variations in the form, quality and ripening period of the fruit occur as in the native plant. These persimmons are grown mostly on native American stocks and on top-grafted native trees. Some of the better known varieties are Hachiya, Hiyakume, which is one of the best, Minokaki, Okame Zengi, a very early variety, etc. A persimmon tree 4 years from crown graft is seen in Fig. 299.

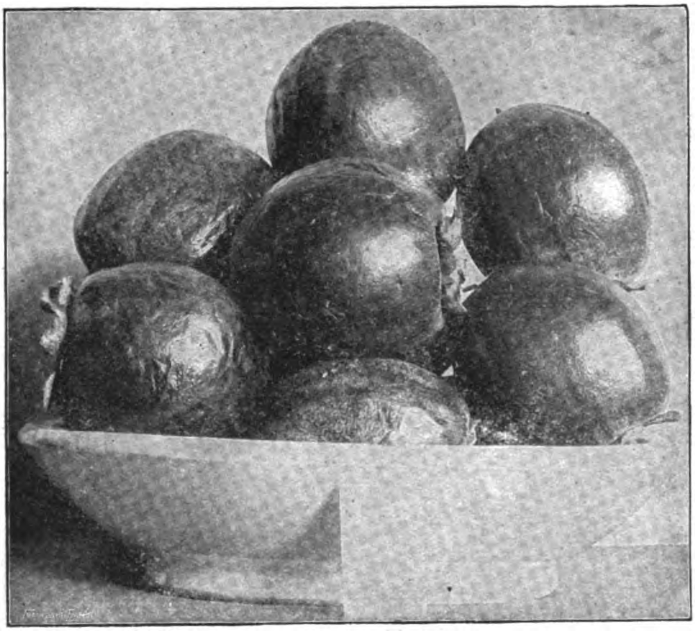


Fig. 298—PLATE OF SHOTO PERSIMMONS
(Reduced one-third; from Ind. Expt. Sta. Bul. 60)

Use—Persimmons are usually consumed in the fresh state. They keep remarkably well, and when stored in a cool place preserve their freshness for weeks. The Hachiya variety is often preserved by drying. Persimmons may be preserved by packing with sugar in a tight jar or placing in a can and pouring over them a syrup made of white sugar and water. It is not necessary to heat the fruit before canning. See also Ind. Expt. Sta. Bul. 60, and Tenn. Expt. Sta. Bul. Vol. XI, No. 1.

Enemies: Root Rot—See under *Grape*.
Bitter Rot—See under *Apple*.
Shot Hole—See under *Peach*.
Aphis—See under *Plant Lice*.
Royal Walnut Moth (*Citheronia regalis*)—See under *Walnut*.

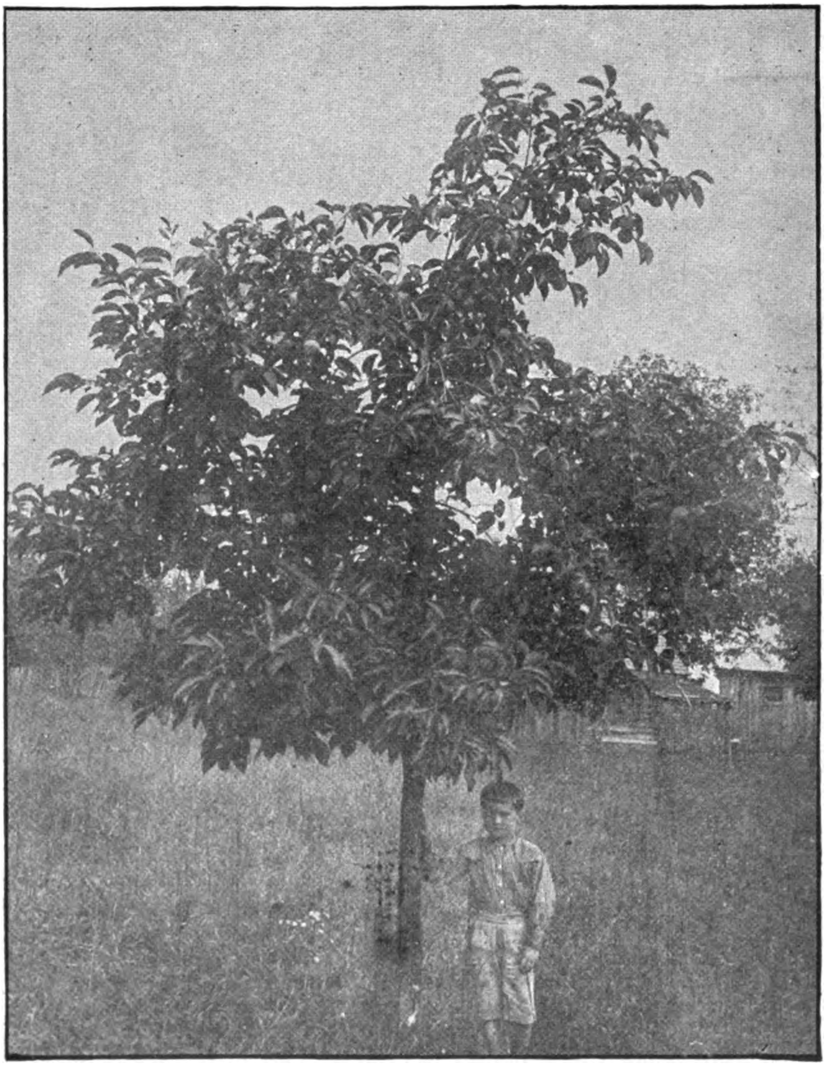


Fig. 299—PERSIMMON TREE, FOUR YEARS FROM CROWN GRAFT
(From Tenn. Expt. Sta. Bul. Vol. XI, No. 1)

PINEAPPLE (*Ananassa sativa*)

This fruit cannot be grown where frosts are prevalent. In this country its commercial culture is largely limited to Southern Florida, where the mean temperature varies between 73° and 76° F. It is propagated mostly from offsets from the parent plant. The suckers that grow from near the base of the plant are most desirable for this purpose, since they are of considerable size, and a fruit can be obtained from them within a year. The slips which are produced at the base of the fruit are also used, as well as the tuft of short leaves at the apex of the fruit, but it requires from 18 months to 2 years to produce fruit from these. A pineapple field in Florida ready for harvest is seen in Fig. 300.

In Florida the soil on which pineapples grow best is a fine sand which is exceedingly poor in plant food. "Hickory scrub" land is considered the best by Florida growers. This consists of an upper layer of 5 to 6 inches of fine white sand analyzing 94 to 99 per cent pure sand, and is underlaid by a yellowish sand. Pineapples have been successfully grown on many other lands. One of the essential factors of a good soil seems to be thorough drainage. The crop withstands drouth well, but succumbs to an excess of water in the soil.

The Florida Experiment Station has conducted a number of fertilizer experiments with pineapples. The results of these experiments suggest that if the plants are set in July or August a handful of fertilizer composed of 3 parts cottonseed meal and 1 part fine ground unleached tobacco dust should be immediately dropped into the bud. This furnishes the plants food and at the same time prevents them from filling with sand.

In October or early November an application of 680 pounds blood and bone and 500 pounds of potassium-magnesium carbonate per acre should be applied. This application should be repeated the following February, or as soon thereafter as danger of frost is past. Shortly before the beginning of the rainy season a third application, consisting of 1000 to 2000 pounds blood and bone and from 750 to 1500 pounds of potassium-magnesium carbonate, should be given. This should be followed by another application in October or early November. Should the plants fail to thrive at any time during the season a light application of nitrate of soda is recommended. In preparing plants for setting in the field a few of the lower leaf scales should be pulled off and the plants set firmly in the soil 2 to 4 inches deep. The rows should be about 30 inches apart and the plants set 15 to 18 inches distant in the row. About all the cultivation required is an occasional light, shallow hoeing to keep down the weeds. The bulk of the crop is marketed from the middle of April to the middle of July.

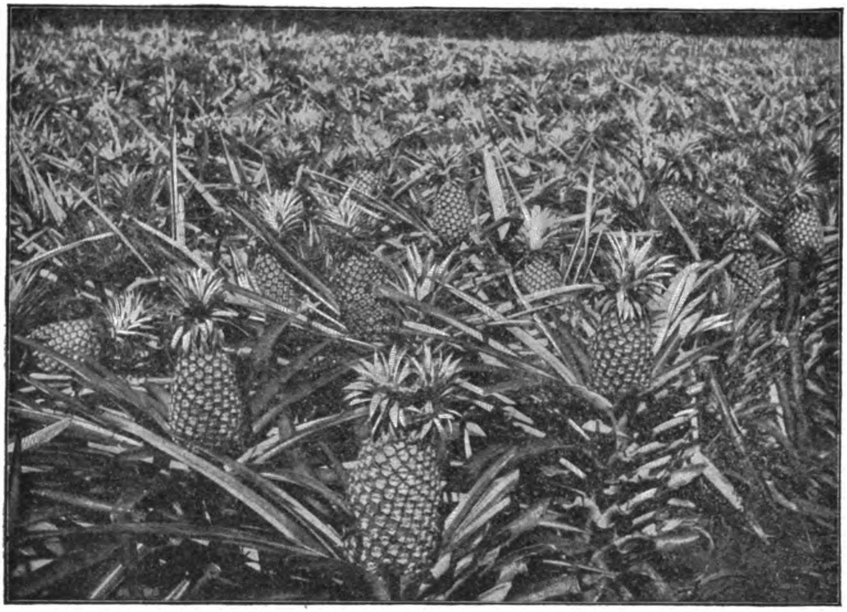


Fig. 300—PINEAPPLE FIELD READY FOR HARVEST
(U. S. Dept. Agr., Office Expt. Stas., Bul. 95)

Within recent years pineapples have been extensively grown under sheds. The sheds protect the plants from frosts and furnish a partial shade, in which they seem to thrive better, and produce fruits of better quality than in the open sunshine. The sheds are usually about 7 feet high and covered over with lath, leaving a space between each lath equal to its width. Inch pine boards 3 inches wide and 18 feet long are also used. The cost for shelter sheds is about $500 per acre. A crop of pineapples growing under a shed is shown in Fig. 301.

The pineapple commonly grown in Florida is the Spanish or Red Spanish. This variety produces fruits varying in weight from 2½ to 6 pounds. The Queen or Golden Queen, a variety with fruits weighing 3 to 5 pounds, stands second in general popularity. Of the fancy varieties, Abbaka, Smooth Cayenne and Porto Rico are most generally grown. For a full account of pineapple growing in Florida see U. S. Dept. Agr. Farmers' Bul. 140.

Enemies: MOLD (*Chalara paradoxa*) appears as a decay of parts of the fruit, accompanied by a development of a blue-gray mold on the rotted surfaces. No direct remedy is known. Diseased fruits should be destroyed.

BLIGHT OR TANGLE ROOT causes the leaves to dry up and turn yellow from the tips downward. The base of the plant rots and the roots grow in a felted mass. Affected parts should be cut away and the plants dusted with sulphur.

LONG LEAF is recognized by the contracted condition and slow growth of the leaves. This trouble may be largely avoided by attention to drainage and by setting the plants at the proper depth.

Pineapples are often attacked by mealy bugs and bark lice. For treatment see *Scale Insects* under *Peach.*

RED SPIDER is found at the base of the leaves, where it multiplies rapidly. A serious rotting sometimes follows an attack of this pest. The red spider may be destroyed by placing a quantity of tobacco dust in the bud of the plant. This is washed downward by rains and 1 application is usually sufficient.

PLUMS (*Prunus* spp.)

There are 3 principal types of plums grown in America. These are: (1) The Domestica or European plums, which include such well-known varieties as the Lombard, Green Gage, Bradshaw, Damsons, etc.; (2) the Japanese plums, sorts which have become popular only within the past 10 years, and (3) Native plums. The Domestica plums are grown chiefly from Ohio eastward and north. They are hardier than the peach, but not quite so hardy as the apple. The Japanese have a much wider range of usefulness and have been successfully grown from Vermont to California and throughout the Southern States. These varieties are strong, vigorous growers, early and prolific bearers, and according to Waugh, hardy wherever the Baldwin apple will grow. The native plums are made up of several different species and

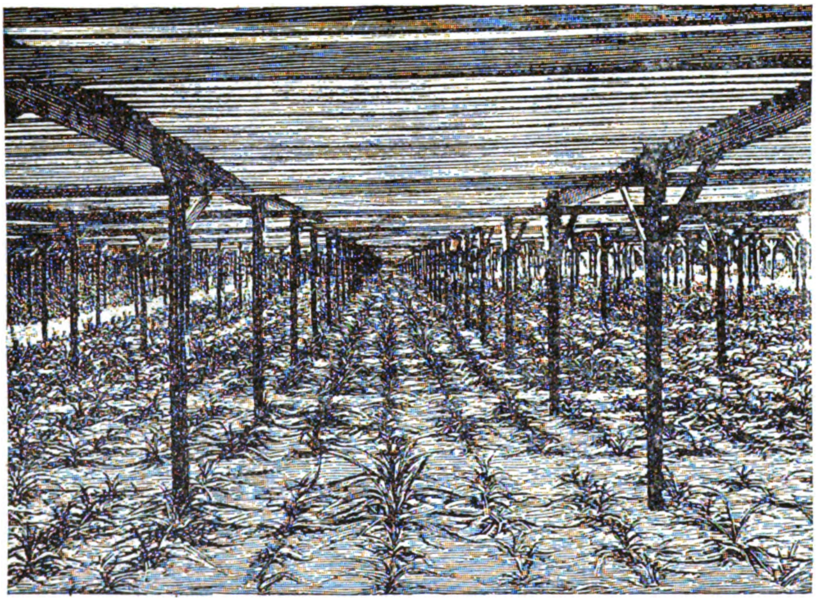


Fig. 301—GROWING PINEAPPLES UNDER SHEDS IN FLORIDA

groups. In general they are not of importance where the Domestica or Japanese sorts can be successfully grown. Varieties of the native Americana plum and of the closely related members of the Nigra and Miner groups are much more hardy than either the Japanese or European plums, and are especially valuable in the Northwest. According to Waugh they are as hardy and can be grown as far north as the sugar maple, and possibly farther. Others of them are well adapted to the Middle and Southern States. These plums are growing in popularity and commercial importance each year.

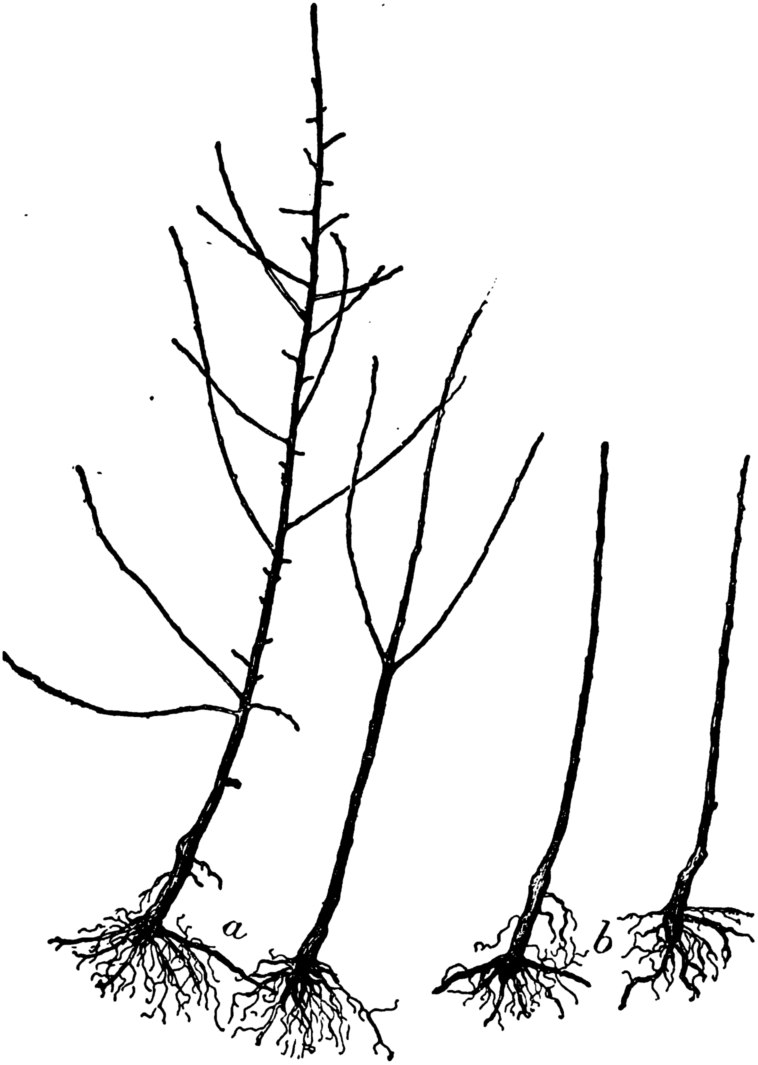


Fig. 302—ONE-YEAR-OLD PLUM TREES
a, unpruned; *b*, pruned for planting

Propagation—Domestica plums are mostly grafted or budded on Myrobalan stock. This is a slow-growing European species. Domestica stock is just as good, and perhaps better, for Domestica plums, but is more expensive. In the South peach stock is largely used. Japanese varieties are for the most part grown on peach roots. Earle states that in the South these plums are now usually budded on stocks of the Marianna plum grown from cuttings. Either June or fall budding (see *Grafting*) may be practiced, but the former is more satisfactory. Americanas are mostly worked on their own seedlings.

It is usually much cheaper to buy nursery trees where only a limited number are required than to grow them.

Soil—Most of the European or Domestica plums, including the Damsons, thrive best on a heavy clay soil. The Japanese require lighter soils, and some varieties do well on even the lighter sandy soils. The native plums grow on a vast range of soils, many thriving especially in the moister loams. In general any good apple or potato soil will be suitable for plums. Heavy or wet soils must be thoroughly underdrained.

Planting—Plum trees should be set about 15 feet apart each way. Some of the larger growing sorts like Burbank should be given 20 feet. The trees may be set either in the fall or spring, but in most cases in the North spring planting will give the better results. Strong 1 to 2-year-old trees should be used. The 2-year-old trees are especially desirable with the Domesticas, including Damsons. In setting out the trees all broken or injured roots should be trimmed off and the top pruned to a straight whip 2 to 3 feet high, with all side branches removed, as shown in Fig. 302. The tree should be planted to about the same depth that it stood in the nursery, or a little deeper. About 4 or 5 branches may be allowed to form the framework of the top. These should start from different places on the trunk, as seen in Fig. 303. The head should be started as low as possible and still permit of the working of the curculio catcher below it. The first spring after planting the 4 or 5 branches should be shortened in from 6 to 18 inches from the trunk, depending on the vigor of the tree. The weaker the tree the more it should be shortened in. On each of these primary branches about 2 secondary branches should be allowed to develop. Generally the plum will not require much shortening in, and pruning suitable for the apple will apply to it. At about the end of the second year in the orchard the trees will come into bearing and give a moderate crop the third year.

Cultivation and Fertilizers—Plum orchards require about the same cultivation as apple orchards. They should be plowed every spring, kept cultivated every 10 days or 2 weeks up until the middle of summer and then seeded down to some cover crop or allowed to run to weeds. In the dry, cold Northwest, however, these directions do not apply. According to Waldron of the North Dakota Station, no cover crop should be sown in the orchard, but cultivation continued until late to preserve moisture. A mulch either of straw, hay or like material should be used to cover the ground over winter. In Wisconsin, Goff found that the mulched trees gave a superior yield and quality of fruit.

As regards fertilizers, a moderate application of barnyard manure every other year, supplemented by wood ashes, will be found to meet the demands of the plum on soils of medium fertility.

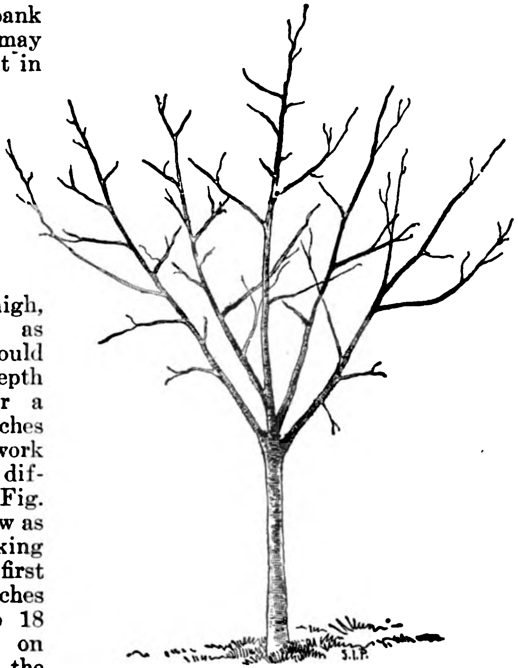


Fig. 303—APPEARANCE OF PLUM TREE AT THE END OF FIRST YEAR IN THE ORCHARD

Thinning and Marketing—The Japanese and the native Americana plums are very prolific, and overbearing is a frequent fault with them. Much larger fruit will be obtained and there will be less likelihood of rot if the fruit is thinned. For the sake of the vigor of the trees, also, and the production of regular crops, thinning should be practiced. Early thinning is best, but late thinning is better than none.

In marketing plums and for jelly making they should be picked about as soon as they are well colored. They should be gathered before they show any tendency to soften. The Japanese varieties, especially, will bear early picking and will ripen up well in the fruit packages. For home canning gather in the first stages of ripening.

Self-Sterility of Plum Blossoms—The investigations of Waugh and others have shown conclusively that "the majority of plums do not bear well, and most of them set no fruit at all unless 2 or 3 varieties are mixed together in the orchard. The reason for this is that the blossoms of most varieties do not pollinate (or fertilize) themselves. They must be pollinated from the blossoms of some other kind of plum. Almost any other plum which blossoms at the same time will answer for the pollination of any given variety." (Vt. Expt. Sta. Bul. 89.) No 2 rows of the same variety should be planted together. A different variety which blossoms at about the same time should come between. The importance of mixing the varieties in the orchard cannot be too strongly insisted upon.

Varieties—The varieties of the different classes of plums are so numerous and their adaptability to different sections of the country so great that nothing more than the briefest suggestions concerning them can be given here. For the Northwest, where Japanese and European sorts cannot be grown, and in the extreme North, the following native varieties are pretty certain to succeed: DeSoto, Forest Garden, Weaver, Cheney, Wolf, Rolling Stone, Wyant, Stoddard, Hawkeye, Smith, Surprise, etc. Native plums well suited to middle latitudes are Wild Goose, Miner, Wayland, Golden Beauty, Cumberland (Fig. 304), Newman, etc.

Of the Japanese sorts, the following varieties, mentioned in the order of their earliness, are given by Bailey as including the more important sorts: Engre, Lutts, Red June, Abundance, Burbank, Chabot and Satsuma. Probably the last 5 are most largely grown.

Of the Domesticas the best known varieties are Green Gage, Reine Claude, Coe Golden Drop, Washington, Lombard, Bradshaw, Quackenboss, Damsons, etc. The Damsons are small plums, with firm flesh, and are especially abundant in old gardens. They are especially desired for preserves. The descriptions of the varieties noted above can be found in most any nurseryman's catalog, and many stations have issued bulletins on plum culture, which include descriptions.

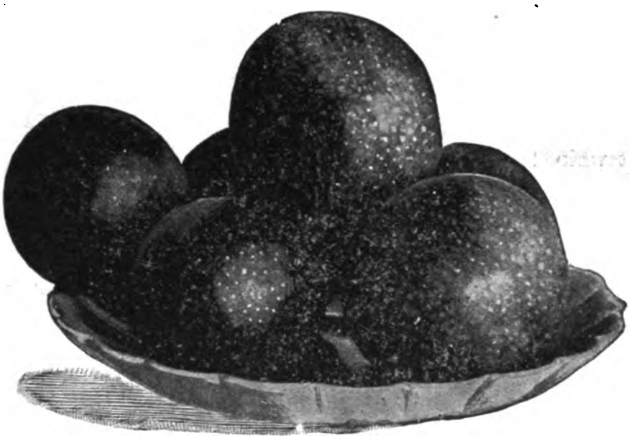


Fig. 304—PLATE OF CUMBERLAND PLUMS
(From Waugh, "Plums and Plum Culture")

This article is based on the following station bulletins, copies of which can usually be obtained by addressing the station director: Ala. Expt. Sta. Bul. 85; Iowa Expt. Sta. Bul. 46; Kan. Expt. Sta. Bul. 101; N. Y. Cornell Expt. Sta. Buls. 131 and 175; Vt. Expt. Sta. Bul. 89; Wis. Expt. Sta. Bul. 63. For a complete treatise on plums consult "Plums and Plum Culture," by F. A. Waugh.

Prunes—Prunes are simply dried plums. Any variety of plum that can be successfully cured without removing the pit may be used for making prunes. Certain firm, sweet-fleshed varieties, however, are especially suited for this purpose. Owing to the difficulty of satisfactorily curing plums in the East prune growing has been largely confined to the

Pacific States. California is the State of largest production, yielding about 85,000,000 pounds yearly. A Silver Prune tree in California is seen in Fig. 305.

In preserving prunes the fruit is allowed to ripen on the tree. It is then graded and either dipped in boiling lye or pricked with needles in a pricking machine. This is done to check the tough skin and make it tender so that the prunes will dry better. The lye method is the one more generally observed. By this method the prunes are dipped for 1 minute or less in a solution made up of 1 pound of commercial lye to 10 to 50 gallons of water. After dipping, the fruit is thoroughly rinsed to remove the lye and then either dried in the sun, as is the common practice in California, or in evaporators, as in Oregon and Washington. It takes from 5 to 12 days to cure prunes in the sun and from 12 to 48 hours in an evaporator where the prunes are started in at a temperature of 120° F. and gradually increased to 160° to 180° F., when the prunes are taken out. For a further discussion of prune curing, consult Cal. Expt. Sta. Bul. 114; Ore. Expt. Sta. Buls. 40, 45 and 56. The general subject of prune growing in the Northwest is considered in Ore. Expt. Sta. Buls. 38, 40 and 45; U. S. Dept. Agr., Div. of Pomol., Bul. 10, to which the reader is referred. The varieties of prunes in general cultivation on the Pacific coast are Petite Prune, Italian Prune and Silver Prune (Coe Golden Drop). The following plums are often grown for prunes: Green Gage, Yellow Egg, Hungarian Prune and many others.

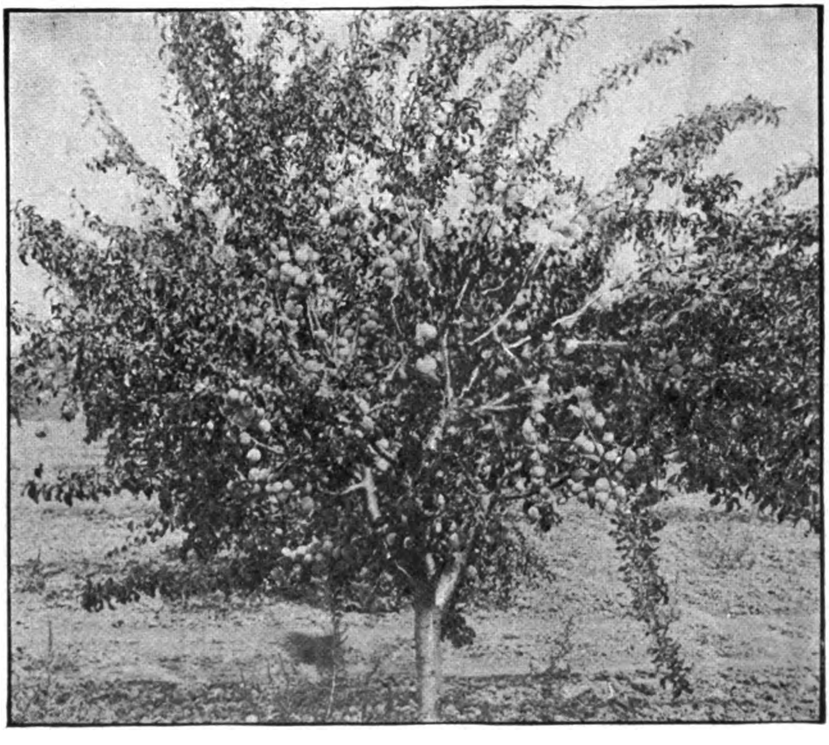


Fig. 305—SILVER PRUNE AS GROWN IN CALIFORNIA

Enemies: BLACK KNOT (*Plowrightia morbosa*) attacks plums and cherries, producing warty growths on the branches, as seen in Fig. 306. Affected branches swell on one side until the bark bursts, exposing a brown spongy mass. Old knots are black and dry. The young knots appear in the spring during the growing season, and later may be infested with insects. Affected branches should be cut off and burned. If the tree is badly infested it should be dug up and burned. The disease may be spread by means of infested wild cherry trees. Spraying with Bordeaux mixture will help prevent the development of black knot.

Canker—See under *Apple.*

Brown Rot—See under *Peach.*

Plum Pockets (*Exoascus pruni*) (Fig. 307) affect the ovary, causing an irregular, inflated bladdery growth without a stone. The interior of such diseased plums is hollow. All leaves from diseased trees and all affected fruit should be collected and burned as soon as they fall. It is also recommended that the ground under diseased trees be sprinkled with air-slaked lime and that the trees be sprayed with Bordeaux mixture before the buds unfold.

Leaf Curl (*Exoascus mirabilis*) causes deformation of leaf buds and young twigs. Structures are thus produced which somewhat resemble plum pockets. Green tips of leaves are often seen projecting from the whitish mass. This trouble may be controlled by Bordeaux mixture.

Rust (*Puccinia pruni*) appears as yellow or red spots on the upper side of the leaves. The peach, prune and nectarine are also attacked in the same manner. Trees may be entirely defoliated when the rust is severe. Spraying with eau celeste or ammoniacal solution of copper carbonate will hold the disease in check.

Powdery Mildew—See under *Apple.*

Scab—See under *Peach.*

Leaf Spot (*Cylindrosporium padi*) appears about the time when the leaves are full grown. Small spots of a purple tinge occur on the leaves. (Fig. 308.) The spots increase in size, run together and finally turn brown, with a pale center. The diseased tissue often falls out, leaving circular holes in the leaves. The best results in the treatment of leaf spot are obtained by spraying with Bordeaux mixture. Several applications should be made, beginning about June 1.

Curculio (*Conotrachelus nenuphar*) (Fig. 309) is a snout beetle 1-5 of an inch long, of a brown or black color. It passes the winter under bark or rubbish and feeds upon the leaves, roots and buds. The female punctures the fruit to a depth of 1-16 of an inch, and deposits her egg in this hole. A crescent shaped furrow is then cut, so as partly to surround the egg. Infested fruit exudes a gummy substance and falls about the time the grub is full grown. The curculio attacks plum, apple, peach, cherry and nectarine. Spraying with a solution of Paris green, 1 pound to 100 gallons of water, or with Bordeaux mixture, to which 2 ounces of Paris green has been added, is an effective remedy. The treatment should be given before the flowers appear, and again 10 days later. The adult beetles may be captured by jarring from the trees into a sheet stretched on a frame, so as to surround the tree. (Fig. 310.) This method should be practiced during the cool parts of the day, when the beetles are relatively inactive.

Gouger (*Coccotorus scutellaris*) is a snout beetle somewhat resembling the curculio. It is yellowish-brown in color. The insect is most injurious in the

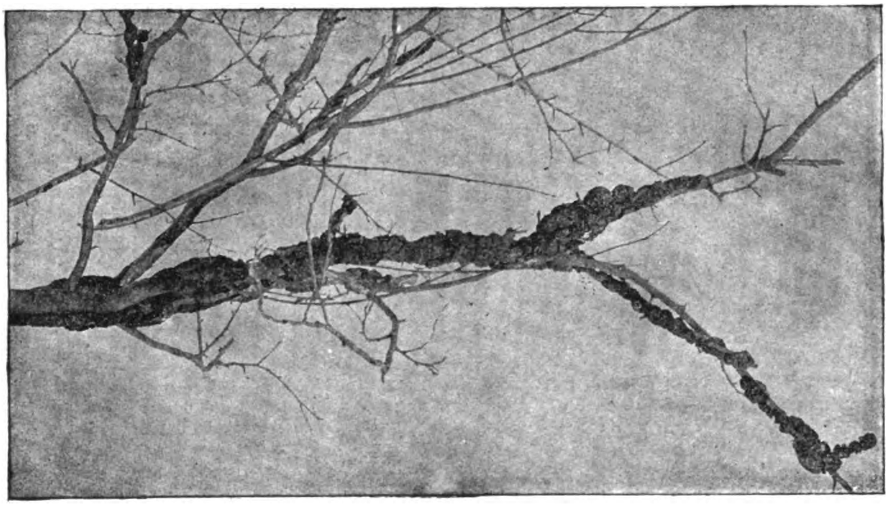


Fig. 306—BLACK KNOT OF PLUM

Western States, and its attacks may be distinguished from that of the curculio by the absence of the crescent mark on the fruit. The grub burrows into the pit and the adult appears in the early fall, and, passing the winter in this stage, deposits its eggs in the following spring for the next generation. Treatment should be the same as for the curculio.

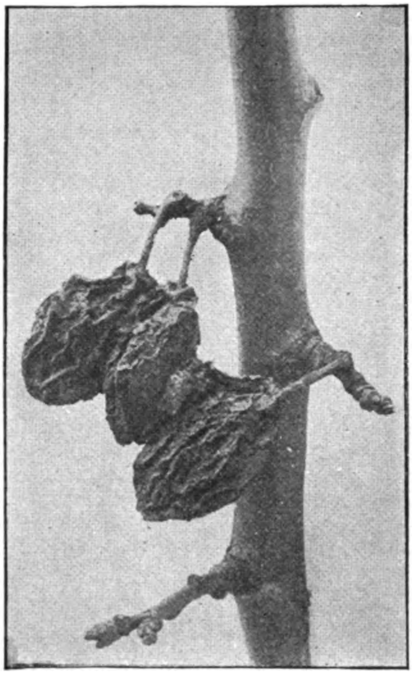


Fig. 307—PLUM POCKETS

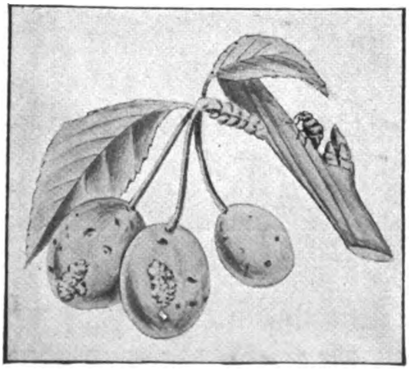


Fig. 309—PLUM CURCULIO
(After Lugger)

BORERS, BUD MOTH, CANKER WORM—See under *Apple.*

SLUG—See under *Cherry.*

TWIG BORER—See under *Peach.*

BARK LICE—See under *Scale Insects.* Branches infested with plum scale are seen in Fig. 311.

APHIS—See under *Plant Lice.*

TENT CATERPILLARS—See under *Apple* and *Maple.*

BLISTER MITE (*Phytoptus phloeocoptes*) resembles the pear-leaf blister mite and causes similar galls on plum twigs. Infested twigs should be pruned and burned in winter, and in spring the trees should be sprayed with a mixture containing 1 pound of sulphur, 2 pounds of slaked lime and 4 gallons of water.

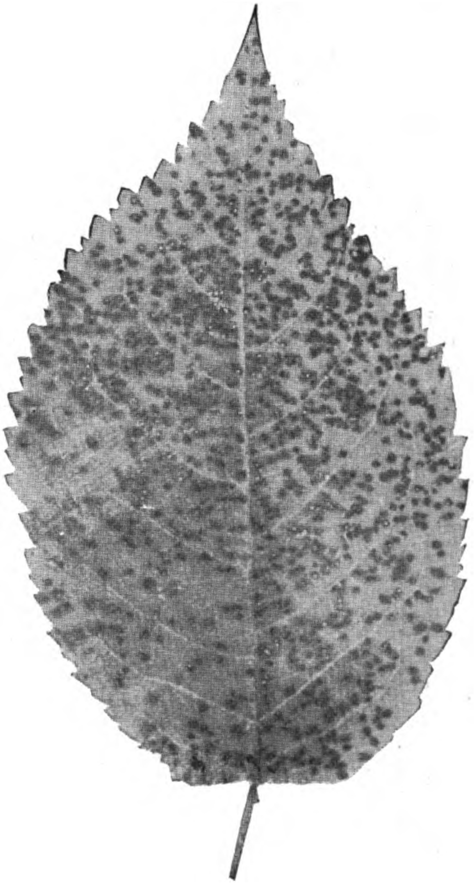


Fig. 308—LEAF SPOT
(From N. Y. State Expt. Sta. Bul. 98)

QUINCE (*Pyrus cydonia*)

The quince is an old-time, hardy garden fruit. It is used for canning and preserves, but is never eaten raw as other orchard fruits are. On account of this the quince is but little grown commercially in this country. Nearly all old gardens, however, have 1 or 2 quince trees in them, and in some sections of the country, like Western New York and some New England States, there are a few quince orchards of commercial importance.

Propagation—The quince is propagated by hardwood cuttings taken in the fall or winter and cut 10 to 16 inches long. The cuttings should be preserved for a couple of months in moist sand to facilitate callusing and planted out in the open ground in the spring. On heavy soils propagation by stooling or grafting on small pieces of apple roots is resorted to. Budding on Angers quince is practiced where propagation by cuttings is not practicable. Quince trees usually remain 2 or 3 years in the nursery before transplanting to the orchard.

Soils and Fertilizers—Quinces do best on a rather heavy, well-drained clay loam, which is retentive of moisture. Good results are also obtained upon the lighter soils, but the trees are not likely to be so productive or long lived. The trees require about the same kinds of fertilizers as are given to the apple orchard. One of the most extensive growers in Western New York uses well-rotted barnyard manure and secures excellent results. Generally this should be supplemented by unleached wood ashes applied at the rate of 100 bushels per acre every other year, or with 200 to 300 pounds of muriate of potash applied broadcast and harrowed in. Phosphoric acid may be furnished in the form of bone compounds or South Carolina rock applied at the rate of 200 to 500 pounds per acre.

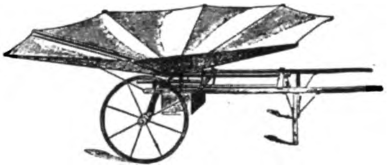


Fig. 310—JOHNSON'S CURCULIO CATCHER

Planting and Cultivation — The trees in the orchard should stand 12 to 15 feet apart each way. As with other orchard fruits, shallow, clean cultivation should be practiced from early spring until August, when all cultivation should stop and a cover crop be sown.

In shaping the tree, the top should be started within 20 inches of the ground and given a wide spreading form. It will not be necessary to head the trees in much unless they make an excessive growth. The trees come into bearing in about 3 or 4 years after they are set in the orchard, but do not reach full bearing until 8 or 9 years old. Fair, average trees will yield 1 bushel of marketable fruit annually. Some years this amount may be doubled. The best grades should be marketed in small packages containing from a peck to a bushel of fruit, while the poorer grades may be packed in barrels.

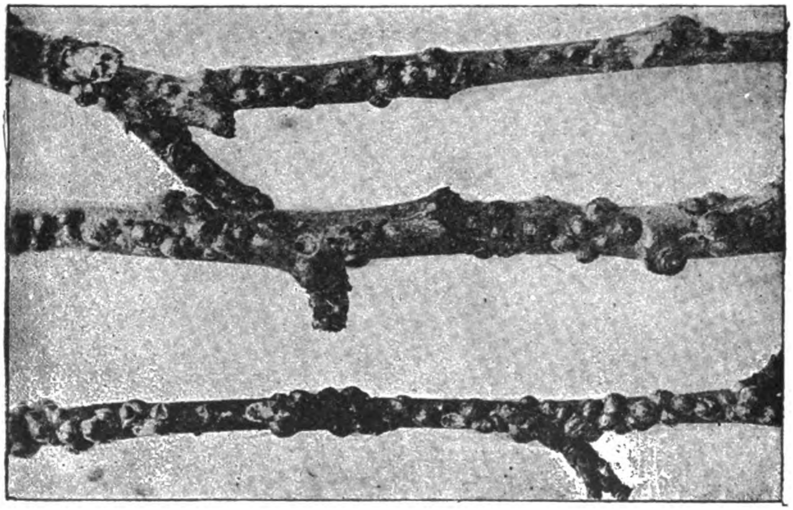


Fig. 311—BRANCHES INFESTED WITH NEW YORK PLUM SCALE
(From N. Y. Cornell Expt. Sta. Bul. 108)

Varieties—There are but few varieties of quinces in cultivation. The Champion, a large, pear-shaped sort, is one of the most productive, but it matures too late for some localities. It is an excellent keeper, and in a test at the New York Cornell Station did not begin to get yellow or soften up until the middle of January, when other sorts had begun to show signs of decay. Orange or Apple quince yields nearly as well as Champion and is probably more generally grown. The fruit is smaller and more apple-shaped. Meech and Rea are other varieties sometimes grown.

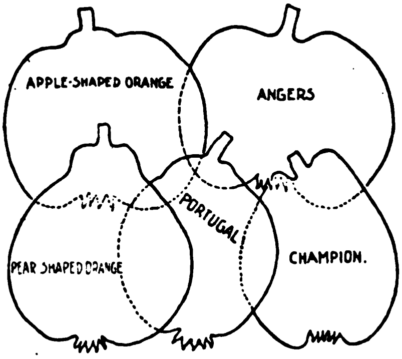


Fig. 312—OUTLINES OF PRINCIPAL VARIETIES OF QUINCES

For a further account of quince culture see Meech's "Quince Culture" and N. Y. Cornell Expt. Sta. Bul. 80, upon which this article is largely based. Fig. 312 shows the shapes and comparative sizes of leading varieties of quinces.

Enemies: BLACK ROT (*Sphaeropsis malorum*) attacks apples, pears and quinces. The disease appears on the fruit when it is about half grown. A discolored patch is seen on the fruit. This area soon exhibits numerous black specks. The fruit finally cracks open and usually remains hanging on the trees over winter. Affected fruit should be gathered and destroyed. Trees should be sprayed with ammoniacal solution of copper carbonate, beginning soon after the fruit sets and repeating the application 2 or 3 times.

FIRE BLIGHT—See under *Pear.*

LEAF SPOT—See under *Pear.*

BITTER ROT—See under *Apple.*

RUST (*Roestelia aurantiaca*) appears on the fruit as an orange fibrous growth. The whole fruit may become affected and fall off. The same fungus causes the development of knots on the twigs. The fungus occurs in another form as the so-called cedar apples on cedar trees. Cedar trees in the neighborhood may be destroyed. Repeated applications of Bordeaux mixture will check the disease on quinces.

CURCULIO (*Conotrachelus crataegi*) is larger than the plum curculio, with a somewhat longer snout and without any warty elevations on the wing covers. (Fig. 313.) The general color is brown, mottled with white. The grub may be distinguished from the larva of the codling moth by the absence of lines. This insect attacks the quince, pear and wild haw. The most effective remedy for combating the curculio consists in jarring and the use of a catcher especially adapted to the low growing habit of the quince. The destruction of infested fruit is not practicable, since it is difficult to determine whether fruit is infested or not. Hogs kept in the orchard may be of some help in reducing the number of curculios. Fig. 314 shows a quince injured by curculio.

LEAF MINER (*Aspidisca splendoriferella*) is a small moth which lays its eggs on the leaves of quince, apple, pear and other related plants. On hatching the young caterpillar mines between the 2 surfaces of the leaf. Later it cuts through the surface of the leaf and fastens the edges together to form a case, in which it migrates to a branch of the tree, where it passes the winter. When the miners occur in large numbers

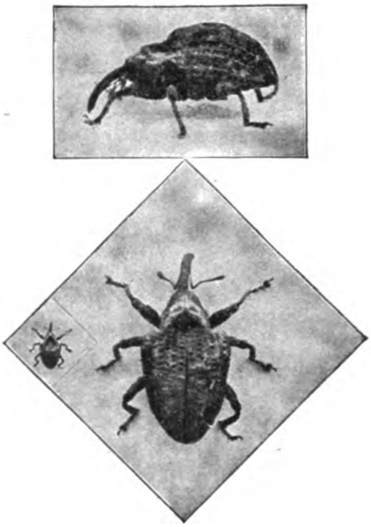


Fig. 313—QUINCE CURCULIO
(From N. Y. Cornell Expt. Sta. Bul. 148)

they may be scraped from the branches and trunk, where they attach themselves, or the trees may be sprayed with kerosene emulsion after the leaves have fallen. In some localities the cases are attached to evergreen trees in winter.

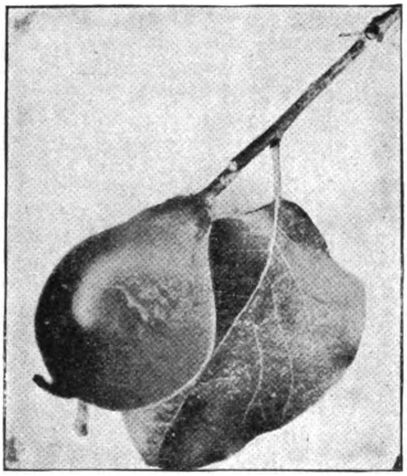


Fig. 314—INJURY FROM CURCULIO
(From N. Y. Cornell Expt. Sta. Bul. 148)

For other insect pests see under *Apple, Plum* and *Cherry.*

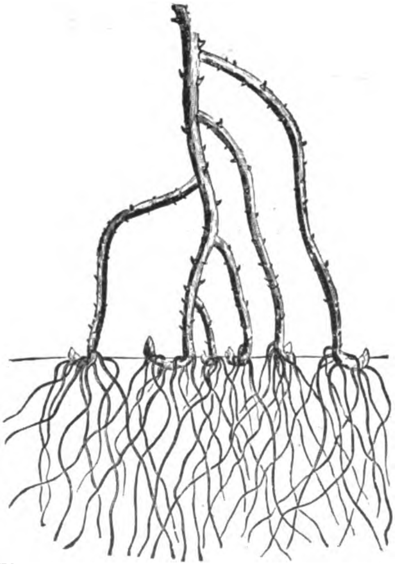


Fig. 315—ROOTED TIPS OF BLACK-CAP CANES

RASPBERRY (*Rubus* spp.)

This bramble fruit is popular everywhere in home gardens, but its culture on a commercial scale is largely confined to the Northeastern States and Pacific Coast. It is the most important of the bush fruits. The 2 species principally grown are the black (*R. occidentalis*) and the red (*R. strigosus*). Both are native to this country. The black raspberry is of most commercial importance. It is more easily grown, yields heavier and the fruit stands shipping better than the reds, though the reds are more relished. Black raspberries are also grown extensively for evaporating.

Soils and Manures—Deep, moist soils well underdrained are most satisfactory for raspberries. The red raspberries do better on the lighter loams, while the heavier, richer loams are better for the black-caps. The best fertilizers for raspberries are those which add humus to the soil like well-rotted barnyard manure; but on fairly rich soils the amount applied to red raspberries should be limited, as it tends to force growth too much.

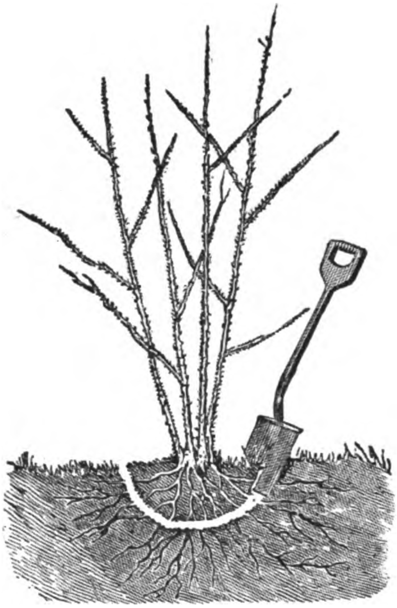


Fig. 316—CUTTING THE ROOTS OF RED RASPBERRIES

Propagation and Planting—Black-caps are propagated by rooting the tips of growing canes late in the summer, as seen in Fig. 315. When these are well rooted they are cut from the mother plant and used for setting out the new plantation. Red raspberries are usually propagated by suckers thrown up from the roots, but root cuttings may also be used. With varieties which do not produce suckers freely the roots may be found to be of greater productiveness by cutting off all the roots in the manner shown in Fig. 316. All the cut-off roots immediately throw up new stems. The plantation may be set out either in the fall or spring, but the spring is usually to be preferred.

The rows of raspberries should be 6 feet apart and the canes set 4 to 5 feet apart in the row. This permits of horse cultivation both ways. The plantation should be kept thoroughly cultivated each season, but spring plowing, as in orchards, is unnecessary and undesirable. In most of the Eastern States the shallow cultivation practiced should cease about midsummer and some cover crop be sown, but in the drier portions of the plains States cultivation should be kept up until the fall to preserve soil moisture.

Pinching and Pruning—Red raspberries require no summer pinching whatever, except a little the first year or so. The black-caps, however, should be nipped off as soon as they attain a hight of 18 to 24 inches. The following spring the laterals of the black-caps should be cut back to 1 to 2 feet, and the reds to a hight of 2½ or 3 feet. They are cut back most on poor soils or with weak canes. The fruit of the raspberry is borne upon short fruit stalks produced from the wood of the previous season's growth. Old cane, therefore, that has fruited once should be removed after the crop is harvested.

Harvesting and Yield—Raspberries marketed in the fresh state are usually picked by hand, the price paid for picking being 1½ to 2 cents per quart. If the fruit is to be dried it is picked by holding an especially made tray under the bushes and knocking the berries off with a small paddle into it. By this method a picker can gather 6 to 7 bushels per day. Some leaves and trash fall in the tray with the berries, but all are dried together and then run through a fanning mill, which readily cleans the berries. Red raspberries are soft and are usually marketed in pint boxes. The Cuthbert is sometimes dried. The average yield of black-caps with good culture is 60 to 80 bushels per acre, though the yield sometimes runs up to 10,000 quarts per acre. Red raspberries yield 50 to 70 bushels per acre and sometimes 6000 to 8000 quarts. It requires about 4 quarts of berries to make 1 pound of dried product. It is not generally profitable to fruit plantations more than 3 or 4 years before plowing them up. Raspberries should not be planted on the same ground again for 3 or 4 years.

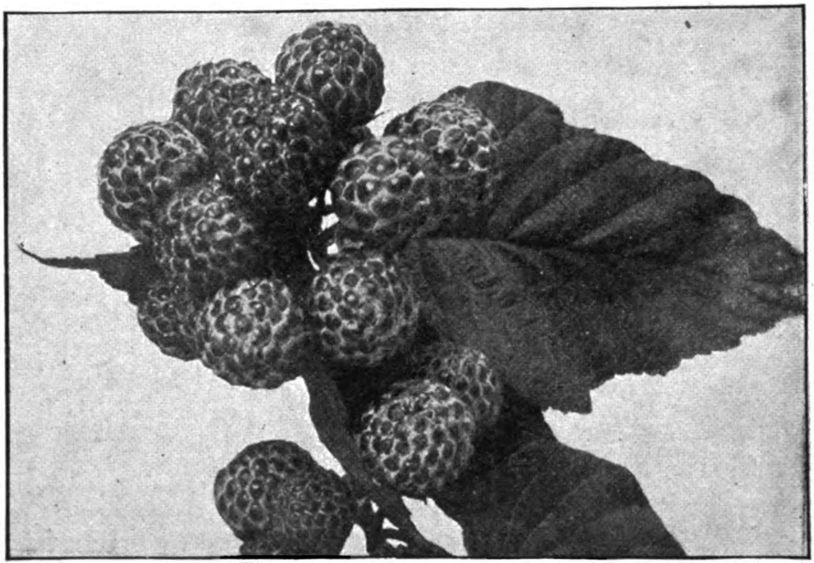


Fig. 317—THE GREGG RASPBERRY
(From N. Y. Cornell Expt. Sta. Bul. 100)

Varieties and Winter Protection—The most popular varieties of black-caps are Gregg, Ohio, Nemaha, Kansas and

Conrath. The Ohio and Gregg (Fig. 317) are the only varieties recommended by the New York Cornell Station for evaporating. Shaffer is the best of the purple-caps. Of the reds, Cuthbert is the standard sort for general cultivation. Turner is a reliable sort for family use, but too soft for market. Hansell is a popular early variety. Yellow Antwerp is a good yellow sort.

Raspberries are not quite so hardy as currants, and in many situations in the Northwest it is necessary to protect them in winter. This is done by removing some of the soil from one side of the roots and bending the canes over lengthwise of the row and covering with coarse manure. (Fig. 318.) The work should be done in the fall before the canes freeze or they will break in bending. In the spring the mulch should be taken off about corn-planting time and the canes righted.

For further notes on the drying of raspberries see N. Y. Cornell Expt. Sta. Bul. 100. For varieties grown in the United States see Mich. Expt. Sta. Bul. 111. For culture of raspberries see N. Y. Cornell Expt. Sta. Buls. 57 and 100; W. Va. Expt. Sta. Bul. 48; "Bush Fruits," by Card, and Fuller's "Small Fruit Culturist."

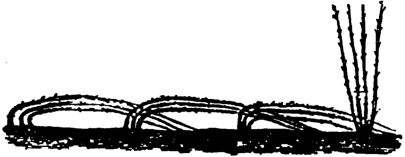


Fig. 318—LAYING DOWN RED RASPBERRY CANES

Enemies: ANTHRACNOSE (*Gloeosporium venetum*) appears on young canes as small round light spots with a purple ring. Larger scabby patches develop on the old canes. The disease may be entirely controlled by cutting out and burning affected canes and by repeated applications of Bordeaux mixture.

CROWN GALL—See under *Apple*.

RUST—See under *Blackberry*.

LEAF SPOT (*Septoria rubi*) attacks dewberry, blackberry and raspberry. It appears on the leaves as large spots containing minute black specks. The disease is not often of great importance. Affected canes should be destroyed.

CANE BLIGHT appears in August as a brown or black discoloration extending two-thirds of the way around the cane. No good remedy is known for this disease. (Fig. 319.)

CANE BORER (*Oberea bimaculata*) is a yellow colored grub, 1/4 of an inch in length. The adult is a black beetle which lays its eggs in June near the tips of raspberry and blackberry plants. The grub burrows downward in the cane and reaches the roots in the fall, passing the winter in the ground. The female girdles the stem at 2 points about 1/2 an inch apart, and deposits eggs between these rings. Wilting of the tips indicates infestation by this insect. Such canes should be cut off below the lower ring and burned.

CANE MAGGOT (*Phorbia rubivora*) is a white, small, footless larva of a grayish-black fly which somewhat resembles the housefly. The insect attacks red and black raspberries, depositing its eggs in April. The maggot burrows into the pith of the canes and after making its way about half the hight of the cane, girdles the stem on the inside. Girdled stems soon wilt or fall over. Infested canes should be cut off near the ground and burned.

GOUTY GALL BEETLE (*Agrilus ruficollis*) is often called the red-necked cane borer and infests raspberry, blackberry and dewberry, producing swellings on the main canes or branches. The beetle is 1/2 of an inch long and with a blue-black back and copper colored neck. Eggs are laid on the stem, usually at the base of the leaf. The grub girdles the stem and bores into the pith, where it continues its tunneling. All canes upon which the warty swellings develop should be cut out and burned.

SNOWY TREE CRICKET (*Oecanthus niveus*) is a pale green cricket-like insect, most frequently found in trees. The eggs are deposited in slits made in the raspberry or blackberry canes, from 10 to 20 eggs being laid in an irregular line. The cane is so weakened by this operation that it splits open. During the immature stages, this insect feeds upon plant lice, and is therefore somewhat beneficial at times. Badly infested canes may be removed and burned.

Raspberries are also injured by the attacks of scale insects, tarnished plant bug (see under *Strawberry*), and other species of less importance.

SAWFLY (*Selandria rubi*) is a black, 4-winged fly, which appears in May and June. The eggs are laid in the substance of the leaves. The larva upon hatching feeds upon the foliage. The larvae are nearly white at first, but soon become dark green in color. They may be easily destroyed by the use of arsenical poisons, hellebore or pyrethrum.

SERVICEBERRY (*Amelanchier* spp.)

Also known as Juneberry or shad bush. Small trees or shrubs with edible fruits resembling blueberries in form. The fruit is native in nearly all parts of the United States and there are several species. Some of the dwarf forms have been introduced into cultivation but the fruit is not yet popular. The dwarf form *A. Canadensis* (Fig. 320) is one of the most promising forms. *A. alnifolia* produces a large amount of fruit of fair quality. The serviceberry is propagated either by seed or by sprouts which spring up around the base of the plants.

STERILITY IN PLANTS

This refers more particularly to the inability, or partial inability of some plants to set fruit when fertilized with their own pollen. Waite first showed that "many of the common varieties of pears require cross pollination, being partially or wholly incapable of setting fruit when limited to their own pollen." The pollen of one variety of pears may be abundantly able to pollenize the blossoms of another variety blooming with it even though it is not capable of pollenizing the blossoms on the same tree or of other trees of the same variety. Two varieties which are absolutely self-sterile to their own pollen may be abundantly able to produce fruit when the pollen of the one is used to fertilize the blossoms of the other. Since the work of Waite on pears appeared (U. S. Dept. Agr. Div. Veg. Path. Bul. 5), the self-sterility or fertility of many other fruits has been studied. Waugh and others have shown that for practical purposes all varieties of native and Japanese plums may be considered self-sterile to their own pollen. Fletcher (N. Y. Cornell Expt. Sta. Bul. 181) has shown that self-sterility is not a constant character with any variety; but that the same variety may be self-sterile in one place and nearly self-fertile in another. Even when varieties are self-fertile to their own pollen, many experiments have shown that larger fruit is usually obtained when the blossoms are cross pollinated.

The practical conclusion brought out by these investigations is never to plant large blocks of 1 variety of fruit alone. The orchard may be barren as a result. At least every third row should be planted to another variety. Care should be taken to select varieties for pollinating each other that bloom together and are interfertile.

The most important agent in effecting the cross pollination of fruits is insects. The wind plays but a small part. A few hives of bees should always be kept where large orchards are planted, to insure cross fertilization. Honey bees are the most valuable of all the insects in securing the cross pollination of fruits.

Some varieties of strawberries produce only pistillate blossoms. Such varieties, of course, produce no fruit whatever unless planted with other varieties that produce an abundance of pollen. This matter is further discussed under *Strawberries.* Where the male and female flowers are borne on separate plants or on separate parts of the same plants, insects to carry the pollen to the pistillate flowers are practically essential to the successful setting of fruit.

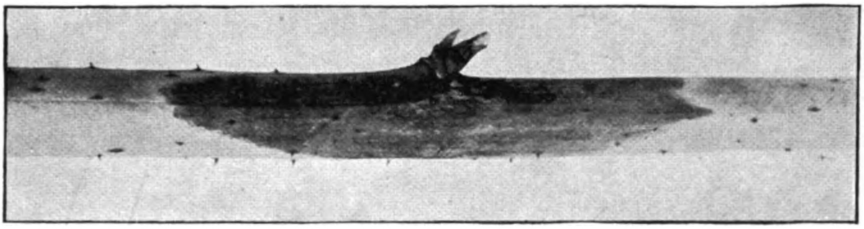


Fig. 319—RASPBERRY CANE BLIGHT
(From N. Y. State Expt. Sta. Bul. 191)

SPRAYING AND OTHER MEANS OF COMBATING FUNGOUS DISEASES AND INSECT PESTS

During the past few years great strides have been made in the manufacture and application of chemical substances for protecting plants against fungous diseases and injurious insects. As a result several effective, reliable fungicides and insecticides have been perfected and successful methods of applying them have been made known.

In the older, more thickly settled portions of the country where fungous diseases and injurious insects have become established, there is no longer any question as to whether it pays to spray. In many localities it is impossible to secure a good crop without spraying. Moreover, careful extensive experiments have demonstrated that the expense of spraying is always justified by the increased returns.

Fungicides are substances which are used for the prevention or eradication of fungous diseases. In the following paragraphs the more important fungicides are considered.

Fig. 320—DWARF JUNEBERRY

Bordeaux Mixture is made of copper sulphate, quicklime and water. The so-called "standard" formula is:

Copper sulphate	6 lbs.
Quicklime	4 lbs.
Water	22 gal.

While the "normal" formula is as follows:

Copper sulphate	6 lbs.
Quicklime	4 lbs.
Water	45 gal.

Recently formulas requiring 50 gallons of water have been extensively used, and equal amounts of copper sulphate and lime are recommended. The strong solution, now most generally in use, contains 4 pounds of lime, 4 pounds copper sulphate and 50 gallons of water, while the dilute solution contains ½ the quantity of lime and copper sulphate, or 2 pounds each. For making Bordeaux mixture the proper amount of copper sulphate may be dissolved by suspending it in a cheesecloth bag in a bucket of water. After being completely dissolved it may be poured into the tank or barrel used for holding the solution. The barrel should be partly filled with water. Thoroughly slake the lime, strain the milk of lime thus obtained into the barrel and add water to make 50 gallons.

Bordeaux mixture is almost a universal fungicide. The 4-4-50 formula may be used on nearly all plants, except cherry, peach and watermelon, on which the 2-2-50 formula should be used.

Ammoniacal Solution of Copper Carbonate, as usually made, contains 6 ounces of copper carbonate, 3 pints of ammonia and 50 gallons of water. To make this fungicide, dissolve 10 pounds of copper sulphate in 10 gallons of water, and 12 pounds carbonate of soda in the same amount of water. The 2 solutions should be slowly mixed when cool, and thoroughly stirred. The mixture should be allowed to stand for 12 hours, after which the liquid is to be poured off and the same quantity of water added as before. The mixture should then be stirred and allowed to stand. This operation should be again repeated. The blue substance which remains is copper carbonate and should be allowed to dry, after which it is to be dissolved in ammonia and water added according to the formula given above. Only enough ammonia should be used to dissolve the copper carbonate. This fungicide is a clear solution and leaves no stain on the plants. It may, therefore, be used on nearly ripe fruits and flowering plants, where Bordeaux mixture might be objectionable. It is cheap and almost as effective as the latter. Insecticides should not be combined with this fungicide.

Simple Solution of Copper Sulphate is made by dissolving from 2 to 4 pounds (according to desired strength) of copper sulphate in 50 gallons of water, as recommended for making Bordeaux mixture. It may be combined with the arsenites but is apt to injure the foliage and should be used before the buds unfold.

Eau Celeste may be made by dissolving 1 pound of copper sulphate in 2 gallons of hot water. After the mixture has cooled 1½ pints of ammonia should be added, and water to make 25 gallons. A modified eau celeste is made by dissolving 2 pounds of copper sulphate in 2 gallons of hot water and 2½ pounds washing soda in the same amount of water. Mix the 2 solutions thoroughly and add water to make 25 gallons. These solutions should not be combined with insecticides. The foliage may be injured by their careless application.

Potassium Sulphid is a very effective fungicide, but it is rather too expensive for use in extensive spraying. For such purposes it is used at the rate of ¼ to 1 ounce in 1 gallon of water. In treating seed grain for smut, potassium sulphid is used at the rate of 1½ pounds to 25 gallons of water.

Corrosive Sublimate (or bichlorid of mercury) is chiefly used as an antiseptic or disinfectant, or in the treatment of seed potatoes for scab. For that purpose it may be used in a solution containing 1 ounce to every 7 gallons of water. It is very poisonous and corrosive to metals.

Formalin (also called formol or formaldehyde) is probably the best fungicide for use in the prevention of grain smuts and potato scab. The commercial formalin contains a 40 per cent solution of the gas in water. It is nonpoisonous and noncorrosive. The fumes are somewhat irritating to the eyes and nose. Seed potatoes may be soaked for 2 hours in a solution containing ½ pint formalin in 15 gallons water. Seed wheat or oats may be soaked for the same length of time in a solution containing 1 pound (1 pint) formalin in 50 gallons of water.

Sulphur has long been used quite extensively in the treatment of surface mildews of plants. Outdoors it is applied in a dry condition, while in greenhouses it is frequently used as a spray at the rate of 1 pound to 5 gallons of water. The fumes of sulphur have considerable fungicide and insecticide value. They may be most successfully produced by evaporating the sulphur over a sand bath or water bath. The sulphur should not be allowed to take fire, for all plants are destroyed by its action when burned.

Hot Water as a fungicide is chiefly used in the treatment of seed grain for smut. (See under *Oats.*)

Many other fungicides have been proposed and used to some extent, but the list given above includes all the important ones which the practical man will find useful in combating the fungous diseases of his crops.

Insecticides—The substances which are used as chemical insecticides may be conveniently divided into 2 classes, those which are eaten and kill by poisoning and those which destroy by contact of the fluid or gas. Of the first class of insecticides the most important group depend for their poisonous property on the presence of arsenic in some form or other, and they are usually known as arsenicals. A large number of arsenicals have been used, but brief notes are here given only on the most important ones.

Paris Green is perhaps the best known and the most extensively used arsenical on the market. Since the Colorado potato beetle has become an important insect pest until the present time, Paris green has been almost the only remedy used for this insect. Paris green should be of a uniform bright green color and should contain not less than 50 per cent of arsenic, nearly all of which should be in an insoluble form. Recent analyses have been made of samples of Paris green by different stations, and it was found that this substance is frequently adulterated with gypsum, flour and white arsenic. In some States, however, no adulteration was detected, and the results of their numerous experiments show that Paris green, as sold on the market, is of rather uniform composition. It may be used for dusting foliage in a dry condition, and when so used should be mixed at the rate of from 1 part to 10-20 parts of flour, ashes or dust. When used in solution with water it should be applied at the rate of 1 pound to 100 gallons of water. Paris green is somewhat less soluble than London purple and is, therefore, less apt to injure the foliage. For tender foliage, such as that of peaches, it should be used in a more dilute solution, as for instance 1 pound to 200 gallons of water. According to some experiments, Paris green is made to adhere more firmly to the foliage when a small quantity of lime is added to the solution before spraying.

London Purple is a waste product, obtained in the manufacture of certain dye-stuffs, and depends for its poisonous properties upon the arsenite of lime which constitutes about ¾ of its bulk. When used as a powder it may be dusted upon plants in the way recommended for Paris green. London purple is less uniform in its composition than Paris green, and is rather more apt to injure the foliage. It should be used at the rate of about 1 pound to 200 gallons of water. A small quantity of glue, glucose or flour paste added to solutions of Paris green or London purple causes them to adhere somewhat longer to the foliage.

Arsenate of Lead was first brought into prominence as an insecticide by the Gypsy Moth Commission of Massachusetts, and later was used almost exclusively by this commission in its spraying operations. The action of arsenate of lead is slower than that of Paris green, but it can be used in greater strengths without danger of injuring the foliage, and remains as a whitish coating on the leaves so that it is easily determined whether or not it has been washed off by rain. Its adhesive qualities are considerably greater than those of Paris green, and it remains on the leaves for a much longer period. Arsenate of lead may be made at home by combining 30 parts of arsenate of soda and 70 parts of acetate of lead. In practice, however, it has been found more satisfactory to buy the arsenate of lead from reliable firms. In experiments with potato beetles in Maine it was considered the most effective insecticide, and it was found that it could be applied more evenly than Paris green on account of its remaining longer in suspension in the water. It may be used at the rate of from 1 to 2 pounds to 150 gallons of water.

Arsenoids—A number of so-called arsenoids have been placed on the market as substitutes for Paris green. These arsenoids are known as white, pink and green, and also by a series of Roman numerals. Experiments with these substances show that while some are effective and harmless, all are not uniformly good, and occasionally the arsenic is in a soluble form and, therefore, injurious to foliage. This defect is especially serious when an insecticide is desired for use on fruit trees or on plants of which the foliage is more easily injured. For spraying potatoes the arsenoids have been found about as effective as Paris green, but there is no reason for using them in the place of Paris green unless they can be bought for a considerably lower price.

Arsenite of Lime is made by boiling lime and white arsenic together for about ½ hour. For this purpose 1 pound of white arsenic and 2 pounds of lime may be boiled in from 2 to 5 gallons of water, and the mixture may then be diluted to make about 100 gallons. This is the chief constituent of London purple, and the insecticide, therefore, possesses many of the properties of the latter. The pure arsenite of lime is not soluble in water and does not injure the foliage. It is cheaper than Paris green and as effective as any arsenical insecticide.

Paragrene is a patented insecticide which contains about 40 per cent of arsenic and about 20 per cent of gypsum, besides other material. It is somewhat coarser than Paris green. In experiments on potatoes no injury resulted to the foliage from its use and the substance proved nearly as effective as Paris green.

In the use of arsenicals the objects aimed at are an effective destruction of injurious insects with a minimum amount of danger to foliage. Paris green, arsenate of lead, London purple and arsenite of lime answer these conditions very well when used in an intelligent manner, and there is no necessity for resorting to patented or doubtful arsenical insecticides until experience has shown that they are equally as effective and not injurious to the foliage.

Hellebore is a yellowish powder made from the roots of European or American hellebore. It is much less poisonous than the arsenicals and loses its strength when exposed to the air for any great period. It may be applied dry or mixed with water. In the form of a powder it may be dusted upon plants in the pure form or mixed with flour, plaster or lime. When used in water it may be applied at the rate of 1 ounce to 3 gallons of water. It is especially recommended for use in the destruction of turnip and gooseberry worms and the larvae of sawflies. For such purposes it may often be used when the application of arsenicals would perhaps be objectionable.

Hydrocyanic-acid Gas was first used extensively in the destruction of scale insects in California and has since become a well-known and effective remedy for this purpose in all parts of the country. The fumes are exceedingly poisonous and strict precautions should be taken against the possibility of breathing them. The gas is generated by combining cyanid of potash, sulphuric acid and water. For fumigating nursery stock in a tight building or a room 1 ounce of potassium cyanid (98 per cent), 1 ounce of commercial sulphuric acid and 3 ounces of water should be used for every 100 cubic feet of space. For green plants or foliage of tender varieties the same amount of chemicals may be used for every 150 cubic feet. For mixing the chemicals an earthenware vessel of 1 or 2 gallons capacity is most suitable. It should be placed on the floor of the room and the necessary amount of water should first be added; then the sulphuric acid is to be poured into the vessel, and the cyanid of potash should be added last. As soon as the cyanid is placed in the vessel the room must be tightly closed immediately, and the treatment should continue for 40 minutes.

In the fumigation of growing trees, several styles of tents have been used, as well as portable boxes or houses which can be readily placed over each individual tree. The general procedure is the same, but the cubic contents of tents have to be estimated since their form is usually quite irregular. For fumigating small orchard trees a convenient portable box was recently devised at the New York State Station which possesses the advantage of being readily managed by 2 men and not breaking or otherwise injuring the small branches of the tree. This method of treatment is the most effective which has yet been devised for destroying scale insects upon citrus and other fruit trees, as well as in greenhouses. It is equally effective against all other insects which may happen to be upon the trees at the time of fumigation, and in fact about the only pests which resist its action are red spiders. If only a few trees require treatment, the method of fumigation may perhaps be considered too expensive, but where treatment must be applied on a large scale, it is the best method to recommend. Recent experiments have shown that the fumes of hydrocyanic acid do not at once become equally diffused throughout the fumigating house. In order to secure a uniform distribution of the fumes it may be desirable to devise some blower or agitator, or, better still, to generate the gas below the floor of the fumigating house proper and allow it to enter through numerous crevices so as to insure a uniform diffusion. The placing of a hoop tent in position is seen in Fig. 321. A fumigator designed and used at the New York State Experiment Station is shown in Fig. 322.

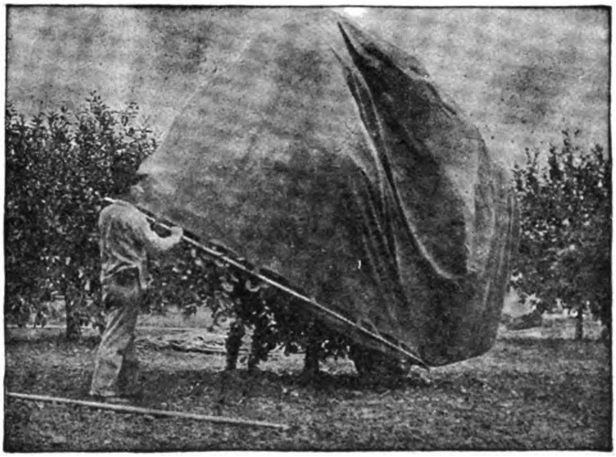


Fig. 321—PLACING A HOOP TENT IN POSITION

Carbon Bisulphid, as sold on the market, is a colorless inflammable liquid. It is very volatile and as soon as exposed to the air gives off the heavy gas which penetrates all parts of the enclosed space. This substance is especially recommended for the destruction of gophers, ground squirrels and woodchucks, as well as various underground insects, such as the woolly aphis and phylloxera. It has also been used against cabbage-root maggot and ants. Carbon bisulphid is almost the only remedy which is generally used in the destruction of grain insects. (See under *Granary Insects.*) For the destruction of underground insects it may be poured into holes, and the holes immediately closed, or may be injected into the soil by means of a syringe prepared for the purpose.

Kerosene, although long known to be a valuable insecticide, has recently come into prominence as a remedy for scale insects and plant lice. Several experiment stations have taken prominent parts in determining the value of this remedy, especially those in New Jersey, Virginia, Ohio and West Virginia. The results which have been obtained from the use of kerosene, while somewhat contradictory in a few points, indicate conclusively that all insects are destroyed by coming in contact with it. It is generally recommended that spraying with kerosene should be done on clear, windy days, preferably during the forenoon, so as to give the best conditions for evaporation of any excess of kerosene upon the tree. Kerosene has been most warmly recommended as a winter treatment for trees infested with San Jose and other scales, and when used during the dormant period of trees may be applied pure upon the hardier varieties of fruit trees. For spraying after the leaves have appeared it is usually recommended that kerosene be sprayed in a mechanical mixture with water containing from 15 to 50 per cent of kerosene. According to some experiments a 25 per cent mixture is equally as effective as pure kerosene and less liable to injure foliage. The mechanical mixtures are made by means of an apparatus usually known as a Kerowater machine, especially designed for this purpose.

Crude Petroleum has recently been used either undiluted or in a mechanical mixture of water, in all cases where kerosene has previously been recommended. In some respects it has proved more effective and more satisfactory than kerosene. A coating of crude petroleum remains longer on the trees and it is more readily determined whether the tree has been thoroughly sprayed. The same precautions are to be observed in spraying with crude petroleum as with kerosene, and it appears from some experiments that all insects are destroyed by spraying with a 25 per cent mechanical mixture of crude petroleum and water.

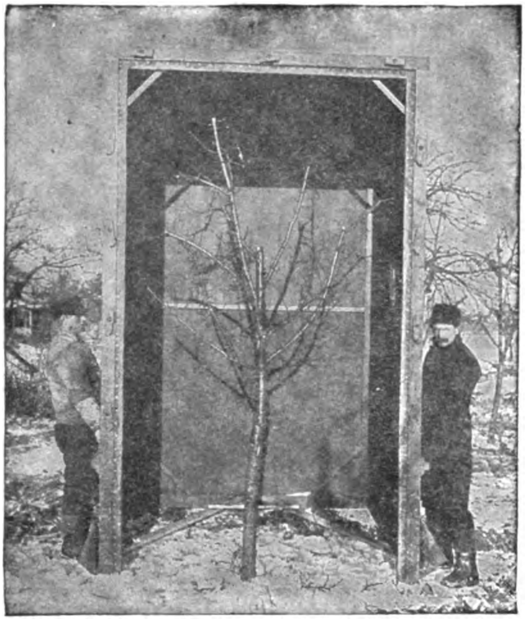


Fig. 322—THE NEW YORK EXPERIMENT STATION FUMIGATOR

The California State Board of Horticulture recommends a distillate emulsion which is essentially an emulsion of crude petroleum and soap. As generally used it contains 1½ pounds of whale-oil soap to 5 gallons of the distillate oil. This insecticide is similar to kerosene emulsion, and before using is diluted with from 12 to 15 parts of water. It is used as a wash for the destruction of scale insects and the eggs of plant lice.

Kerosene Emulsion is made with soap or with milk. The soap formula contains 2 gallons of kerosene, ½ pound whale-oil soap, or the same amount of hard soap, and 1 gallon of water. The soap should be dissolved in boiling water and the solution mixed with the kerosene by violent agitation. Before using it may be diluted with from 15 to 20 parts of water, according to the plants which are to be sprayed. Kerosene emulsion is especially recommended for the destruction of plant lice, leaf-hoppers and thrips. The milk formula contains 2 gallons of kerosene and 1 gallon of sour milk, which are made into an emulsion by from 3 to 5 minutes' agitation. The mixture should be diluted the same as in the soap formula.

Kerosene, when applied to the surface of pools and stagnant water, at the rate of 1 ounce to 15 square feet of surface, is a very effective remedy for the destruction of mosquito larvae. Kerosene and petroleum, whether undiluted, mixed with water, or in the form of emulsions, should be used in an economical manner, partly because insecticides with these substances are rather expensive, and partly because injury may result to the bark or leaves from an excess of kerosene upon the foliage. It should be understood that kerosene or crude petroleum may be sprayed upon the trees in full leaf without injury to the foliage. At times, however, great injury results from such application and the conditions which determine these differences in results are too complex to be discussed in this place. It is safer, therefore, to use kerosene and crude petroleum as winter applications, or somewhat diluted with water, if it is necessary to spray when the foliage is well developed.

Lime, Salt and Sulphur Wash is a winter application for the destruction of scale lice and is an especial favorite in California and on the Pacific coast. It is made by placing 30 pounds of lime, 20 pounds of sulphur and 15 pounds of salt in a barrel containing 30 or 40 gallons of water, and boiling the whole by means of steam for 3 or 4 hours. Before using, the mixture should be diluted to make about 60 gallons of wash. It is most effective when applied warm. The mixture is of some value also as a fungicide. At first this wash and the Oregon wash, in which blue vitriol is substituted for the salt, found little favor in the Eastern States. Recent experiments in Illinois and elsewhere show both of these washes to be very effective and perfectly harmless to the trees.

Resin Wash may be made by placing 20 pounds of resin, 4½ pounds of caustic soda and 3 pounds of fish oil, together with about 13 gallons of water, in a large kettle, and boiling for from 3 to 10 minutes or until the resin is dissolved. While hot, enough water should be added to make 15 gallons of the whole mixture. For use in spraying, the stock solution should be diluted with 9 parts of water. When prepared as just indicated, the mixture may be diluted so as to make 150 gallons. This insecticide is useful in destroying scale insects and is especially recommended as a treatment for sooty mold of orange. This fungus grows upon the honeydew produced by insects, and when the latter are killed the sooty mold disappears.

Quassia Chips are made from the wood of *Pichraena excelsa,* and are much used for making a decoction to destroy plant lice. For this purpose 1 pound of quassia chips is boiled in water, and the decoction is then diluted so as to make 8 gallons. A still more effective insecticide is produced by using 8 pounds of quassia chips and 7 pounds of whale-oil soap to 100 gallons of water. This preparation is especially adapted to spraying for plant lice on fruit trees and hops.

Tobacco is employed as an insecticide in several ways. It is chiefly effective against plant lice and other sucking insects. Greenhouses may be effectively fumigated by burning tobacco stems. Tobacco dust and stems are often buried in the soil around apple trees infested with woolly aphis. The water soaking through the soil carries with it a solution of the tobacco which destroys the woolly aphis. A decoction of tobacco is made by steeping the stems in water until the strength of the tobacco is thoroughly extracted and then diluting the solution until it has about the color of ordinary tea.

Soaps are frequently used for the destruction of plant lice and soft-bodied larvae. Any good soap is fairly effective for this purpose, but whale-oil soaps are especially valuable. Potash soaps are considered more effective than those made from soda. Soft soap may be used as well as hard, but should be taken in larger quantities. Whale-oil soap may be dissolved in water by boiling 2 pounds in a gallon of water. This insecticide is not only useful against plant lice, but is also recommended as an effective winter application against San Jose scale and other scale insects.

PYRETHRUM, also known as buhach and Persian insect powder, is made of the pulverized flowers of Pyrethrum plants. It is chiefly used in greenhouses and in the destruction of household insects, where arsenical poisons might be dangerous or otherwise undesirable. It is used in the form of a dry powder or as a spray at the rate of 1 ounce to 2 gallons of water. For the destruction of mosquitoes in houses, pyrethrum produces effective fumes when burned.

SULPHUR is perhaps the best remedy for plant mites, such as the common red spider, the rust mite of citrus trees, and the 6-spotted orange mite. For this purpose it may be best applied as a dry powder and dusted over the trees with powder bellows. Sulphur may also be added to other insecticides, such as resin wash, soap mixtures or kerosene emulsion, at the rate of from 1 to 2 pounds to 50 gallons of the insecticide. A lye-sulphur wash may be made by making a paste of 20 pounds of sulphur, to which 10 pounds of pulverized caustic soda is added. Water is to be poured upon the mixture from time to time until a solution of 20 gallons is obtained. This may be used as a stock solution, and for spraying purposes 2 gallons of the stock solution may be diluted to 50 gallons.

HOT WATER furnishes means for destroying root lice, especially the woolly aphis. Water at nearly a boiling temperature may be poured about the base of young trees without danger of injuring the trees. Before applying the hot water a few inches of the soil should be removed from around the tree. Infested nursery stock may be treated by immersion for a few seconds in water maintained at a temperature of from 130° to 150° F. For the destruction of pea weevils it has been found sufficient to expose seed peas for a short time to a temperature of 145° F. The same results may be obtained by soaking infested seed for 1 minute in boiling water.

Mechanical and Other Methods of Fighting Insects: BANDING of trees has been quite generally employed as a means for preventing insects from climbing up into the trees from the ground. It is especially effective in cases where the female insect is wingless, and for preventing the ascent of caterpillars. The female canker worms are thus captured, as well as the caterpillars of various other species. For such cases tarred paper or tarred bands made in other ways are easily adopted. Other sticky substances, such as Raupenleim, have been used for the same purpose. Bands of burlap, other kinds of cloth and straw are used for the purpose of entrapping caterpillars. Such bands are inspected at regular intervals, and any caterpillars which have collected under them are destroyed. Experiments have shown that this method is quite effective in some localities against the codling moth. Banding trees with burlap has been most extensively adopted by the Gypsy Moth Commission in combating the caterpillars of the gypsy moth.

JARRING is a method especially suited to catching insects which readily drop to the ground when disturbed. The insects against which the method has been most used are the plum curculio, rose beetles, tarnished plant bugs, and caterpillars which drop from the trees and hang by a thread. For catching such insects when jarred from infested plants it is necessary to have some form of a sheet or canvas stretched on a frame under the tree at the time of jarring, The insects are then to be immediately destroyed. In the case of the tarnished plant bugs and rose beetles, the jarring method can only be successfully operated during the cool part of the day when the insects are not especially active.

DEEP PLOWING—In the case of certain insects which pass the immature stages in the ground, the larvae may be so deeply buried by plowing that they are unable to reach the surface. This method has been successfully used in combating the Rocky Mountain locust. In this case the eggs are laid at the depth of about an inch or two, and when deep plowing is resorted to the young locusts are unable to escape after hatching.

BURNING is a remedy which may be applied in a great variety of cases. Badly infested strawberry beds should be mowed immediately after harvest and burned over. Where wheat is infested with the Hessian fly, the stubble should be burned as soon as possible after harvesting. In general, where cultivated crops are infested with insects which pass any of their stages under leaves or other rubbish on the ground, it is advisable to burn such material at a time when the insects will be destroyed. The Rocky Mountain locust in its younger stages may be enticed under straw and then destroyed by burning the straw in the evening after the locusts have collected together.

TRAP CROPS—The intelligent use of trap crops sometimes furnishes an effective means for getting rid of certain injurious insects. It often happens that insects prefer certain other plants to the one which is being cultivated on a given area. By cultivating a few of these preferred food plants around the field of the cultivated crop, and then spraying such trap crops heavily with Paris green or other arsenical poison, the insects may be readily destroyed. In such cases the arsenicals may be used in stronger solution than would be advisable upon the plants which are desired for food or other economic purposes.

HOPPER-DOZERS were first devised for the destruction of Rocky Mountain locusts and other locusts. A form of hopper-dozer has also been found effective in combating leaf-hoppers on grasses. The most common form of hopper-dozer consists of a pan of galvanized iron or similar material, about 4 inches deep in front and 8 inches deep at the back. The pan is usually about 2 feet wide and may be of any convenient length. For use on a large scale a long pan is desirable. The pan is divided at intervals of 12 inches by partitions of galvanized iron, and is mounted on a platform, which in turn is carried upon wheels or runners. The whole apparatus is propelled by horses, and as it is drawn across the field the grasshoppers spring into the air and fall back into the pan. The pan should be nearly filled with water, upon which a film of kerosene oil is maintained. This apparatus is especially useful in capturing the locusts during their younger stages, and is not effective after the insects are able to fly vigorously.

DITCHES AND IRRIGATION — Insects which travel in armies, such as the army worm, chinch bug and certain species of cutworms, may sometimes be prevented from entering fields that contain cultivated crops by erecting barriers of boards smeared with tar or crude petroleum, or by digging ditches with a perpendicular wall toward the cultivated crop. The ditches may be supplemented with holes dug at intervals, into which the insects fall and in which they may be destroyed. Where water is to be had for irrigation purposes, an effective method of stopping an army of cutworms or other insects consists in running an irrigation ditch between the army of insects and the cultivated crop and keeping a regular and constant stream of water flowing in the ditch.

Where irrigation is practiced it is easily possible to destroy certain insects by irrigating the fields or submerging them for a certain length of time under water. The latter method is frequently adopted in combating injurious insects in cranberry bogs. In case of the ordinary cultivated crops, irrigation is not especially effective in destroying insects, since the crops are liable to injury from overirrigation and insects are not destroyed by short immersion in water.

CUTWORMS and ARMY WORMS may, under certain conditions, be destroyed in large numbers by rolling with a heavy roller. This method is not effective when the insects are hidden in the soil, but is only to be adopted when they are crawling upon the surface. When fields of grain 3 or 4 inches in hight are attacked by cutworms or army worms the method of rolling may often prove of great service.

EGGS AND COCOONS—The egg masses and cocoons of certain insects are very conspicuous and may be readily detected, collected and destroyed. This method should be adopted to some extent in all cases where it is readily practicable. The collection or destruction of egg masses is possible in the case of the gypsy moth, apple-tree tent caterpillar, white marked tussock moth and various other insects. The cocoons of some insects are attached to twigs or other objects, where they can be readily seen and may be collected and placed in cages made of fine meshed wire so as to prevent the escape of the insects and to allow any parasites which they may contain to make their escape.

FIGHTING INSECTS WITH FUNGOUS DISEASES—Various species of insects are often attacked and destroyed by parasitic fungi and bacteria. Considerable work has been done in this and other countries in making artificial cultures of different species of parasitic fungi for the purpose of distributing such fungi or diseased insects among farmers and fruit raisers. In fighting the chinch bug considerable success has been had by the use of a fungus known as *Sporotrichum globuliferum,* which causes a so-called white muscardine disease of chinch bugs. This has been cultivated at several experiment stations and at the State

University of Kansas for distribution among farmers who are suffering from attacks of chinch bugs. A fungous disease of San Jose scale has been discovered which seems to be of considerable importance in checking this insect, as well as the fluted scale and other scale insects. The disease has been experimentally disseminated by means of twigs infested with diseased scale insects. In some of the English colonies, especially in South Africa, good results have been obtained in combating locusts by means of a parasitic fungus, and this fungus has recently been imported into the United States in the hope that it will prove effective in checking the Rocky Mountain locust.

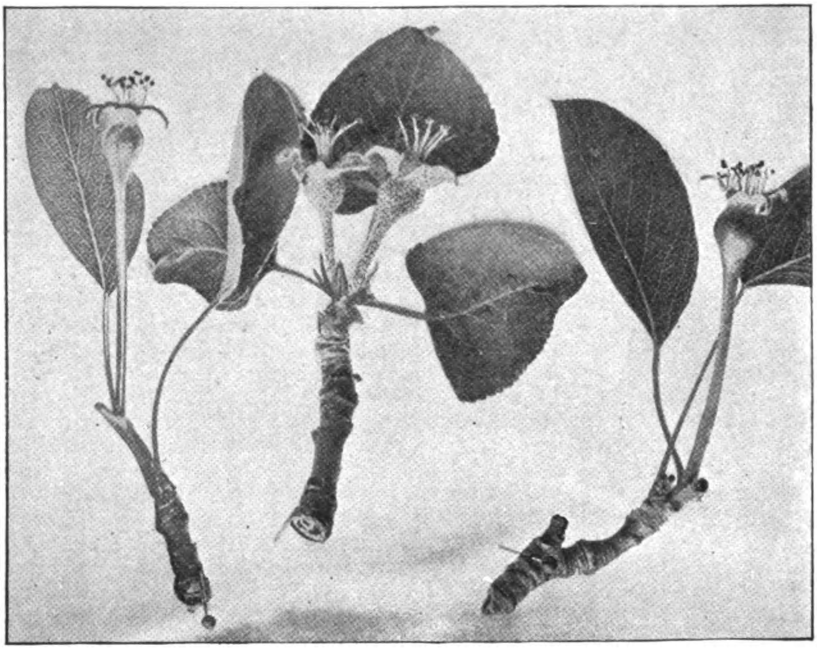


Fig. 323—RIGHT STAGE FOR SPRAYING APPLE BLOSSOMS FOR CODLING MOTH (From N. Y. Cornell Expt. Sta. Bul. 142)

Beneficial Insects—In the work of destroying injurious insects it should be remembered that considerable help is received from predaceous and parasitic insects which feed upon or destroy the injurious species. Some of the more common groups of these beneficial insects may be briefly described in this place.

SYRPHUS FLIES are bright colored flies, some of which closely resemble the bees or wasps in their general appearance. The adult flies are most frequently seen around various flowers, especially goldenrod. The larvae of certain species are small greenish slug-like insects, which feed almost exclusively on plant lice, and are frequently to be seen among colonies of plant lice on fruit trees, cereals and other cultivated crops.

LADY BEETLES are easily recognized by their hemispherical shape, red or yellow color and black spots. The larvae are active grubs of bright color and covered with warts or spines. Both the adults and larvae feed upon plant lice and are considered of great value for this purpose. Considerable effort has been spent in introducing species of ladybirds from other countries to the United States to help in the destruction of scale insects. The fluted scale in California was almost exterminated by a lady beetle which was imported from Australia.

LACE-WING FLIES are delicate insects with relatively large, thin pale green wings. The larvae resemble those of ladybirds, but are somewhat more slender and less spiny. They feed upon plant lice and other soft-bodied insects.

Nearly all species of insects are known to be attacked by 1 or more insect parasites. The more common parasites belong to the 2-winged or 4-winged flies. These parasites may develop in the egg, larval or pupal stage of the host insect, and usually cause the death of the latter only after a considerable period. Some stages of parasitic insects are frequently observed. The small white cocoons on the backs of tomato worms have been observed by nearly all careful gardeners, and are 1 stage of the parasite which destroys this enemy of the tomato. Plant lice which are attacked by parasites are distinguished by their swollen appearance and brown color, and may often be seen in large numbers among colonies of plant lice which are feeding on cultivated plants. Many experiments have been made in shipping parasites of injurious insects from one country to another to assist in the destruction of insect pests, and some success has attended these efforts. The practical farmer or gardener should be able to recognize the many forms of predaceous and parasitic insects in order to avoid destroying them along with the injurious species during his insecticide operations.

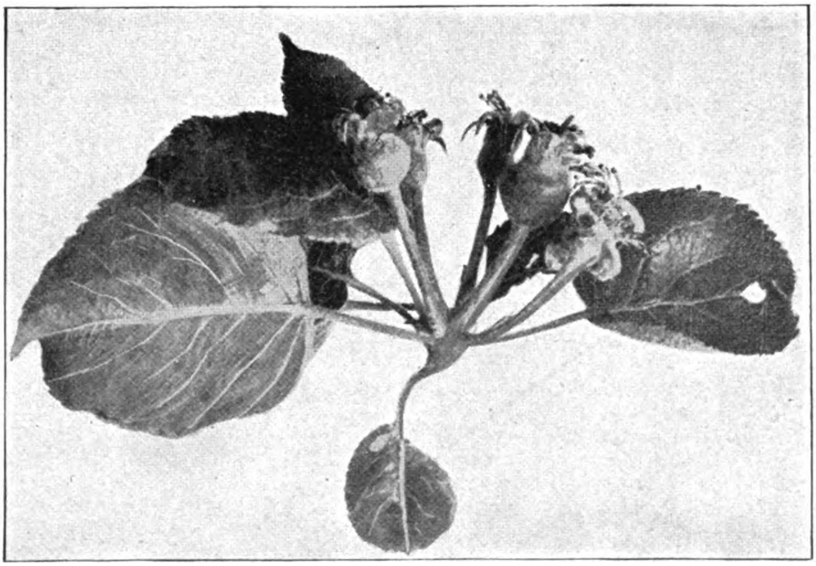


Fig. 324—SPRAYING OUT OF BLOOM
(From N. Y. State Expt. Sta. Bul. 196)

Spraying Apparatus—The choice of machinery for spraying will depend largely on the kind of plants to be sprayed and the extent of the spraying operations. The apparatus will range in size and complexity from the simple hand atomizer for use in spraying greenhouse plants, through the various forms of bucket pumps, knapsack sprayers and barrel pumps, to the large tanks with pump attachments, operated by horse power or by gasoline or steam power. For spraying an orchard or potato field of moderate size a 50-gallon barrel or a tank holding 100 gallons is suitable. Either receptacle may be mounted on wheels or placed in a wagon. A strong force pump is to be attached and may be operated by hand or by horse, gasoline or steam power. For special purposes special devices are required. For instance, in spraying potatoes or cotton, a long, horizontal extension rod may be connected with the tank and may be fitted with attachments so as to spray several rows at the same time.

All apparatus used in spraying should be strong, durable and not likely to corrode. Hose should be strong enough to endure considerable pressure. The nozzle should throw an even and finely divided spray. Much of the success of spraying depends on all the foliage being well covered without too great an excess of material in any place.

A great variety of nozzles are manufactured and depend upon various mechanical principles, for the formation of a fine spray. There is no nozzle which is equally well suited to all purposes. The choice of a nozzle will depend on the kind of work to be done. Illustrated catalogs of spraying machinery may be obtained by writing the various manufacturers thereof, whose advertisements are usually to be found in the agricultural papers.

Where possible it is generally recommended that fungicides and insecticides should be combined in 1 spraying. The most common combination of this sort is Paris green and Bordeaux mixture. Apple trees should be sprayed 3 or 4 times each season with this combined fungicide and insecticide, before the blossoms and buds open, immediately after the blossoms fall, as seen in Fig. 323, and a third and fourth time at intervals of about 2 weeks. In this combined mixture Paris green may be used at the rate of ¼ pound to 50 gallons of the mixture.

Many other combinations of fungicides and insecticides have been tried with varying results. Attempts to combine contact insecticides, arsenicals and fungicides have been mostly unsuccessful. Recent developments, however, in the manufacture of machines for making mixtures of kerosene and water have made the preparation of combined mixtures a much simpler matter.

Finally—Success in spraying is obtained by doing the work thoroughly and in an intelligent manner. Do not spray except for a specific purpose. Do not spray fruit trees when in bloom. The bees might be poisoned and the trees fail to be fertilized. The right time to spray for codling moth is shown in Fig. 324. It is not always wise to wait until some fungous disease or insect pest has appeared before spraying. Where experience has taught that certain fungous diseases are to be expected, preventive treatment with Bordeaux mixture should be given before their appearance. It is always necessary to spray more frequently in rainy weather, since the rain washes off the spraying materials. The effect of spraying is illustrated in Fig. 325.

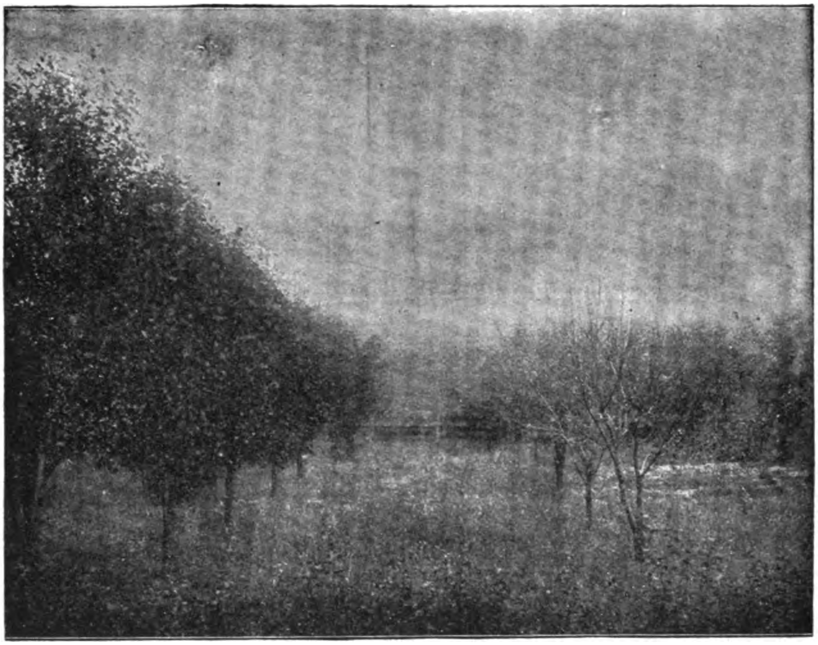


Fig. 325—SPRAYED AND UNSPRAYED TREES

STRAWBERRY (*Fragaria* spp.)

There are about a dozen species of strawberries in the world, and 7 of these are native to North America. The parent of most of our cultivated varieties is *F. Virginiana.* The wild plants are familiar all over the United States. The cultivated strawberry is much larger than the wild form and is superior to it in flavor, aroma and shipping qualities. The strawberry is one of the most important small fruits, and is the first fruit of spring everywhere. The experiment stations have recognized its importance and published more than 200 bulletins and reports upon it, many of which contain much experimental data of value. This article is based on these reports.

Location and Soils—A southern exposure gives early berries, while a northern exposure delays and prolongs the ripening period. Hill lands are less liable to frosts than lowlands. Level land is especially desirable where irrigation is practiced. With regard to soils, clay loams—other things being equal—are more productive than sandy loams. On the other hand, the earlier fruit is obtained on the sandy loams. In New Jersey 306 growers on clay loams secured an average of 3223 quarts per acre; while 387 growers on sandy soils secured an average of 2359 quarts per acre—a gain of 864 quarts per acre for clay soils. New fertile woods soil is especially desirable and generally gives much better results than old soils.

A good general rule is as follows: For early crops select a quick sandy loam, southern exposure, and early varieties; for late crops, a northern exposure, clay soil, and late varieties.

Fertilizers—Strawberries are not an exhausting crop on the land. Nevertheless, on account of the rapid growth of the plant and early maturity of the fruit, they require an abundance of fertilizers. Well-rotted barnyard manure is one of the very best fertilizers for strawberries and the one oftenest recommended by the experiment stations. If it is not well rotted it is generally foul with weed seed and diseases and tends to produce a rank growth of vine and a fruit of poor shipping quality. To supplement the barnyard manure from 50 to 100 bushels per acre of unleached wood ashes should be applied with it. This supplies an abundance of potash, which barnyard manure is usually lacking in. If ashes are not to be obtained sulphate or muriate of potash may be used. On soils already rich in humus, like muck soils or old truck garden soils, potash and phosphatic fertilizers are of much more value than nitrogenous fertilizers. Besides the fruit grown with these fertilizers is likely to be much better colored, better flavored and firmer than with nitrogenous fertilizers.

Experiments at the New Jersey and other stations show an increased fruit yield of from 18 to 31 per cent by the use of 200 pounds per acre of nitrate of soda applied broadcast in the spring after the foliage had gotten well started, but before the bloom appeared. Plants thus treated showed a deeper color, much stronger bloom, larger leaves and greater freedom from rust than plants not receiving the soda. Where nitrate of soda is thus used care should be taken that there be plenty of available phosphoric acid and potash in the soil or the vine growth will be excessive. Experiments in Florida, where berries are shipped a thousand miles to market, indicate that nitrate of soda may injure the shipping quality of the fruit and should not be used on the plants for at least 3 months before shipping begins. With this exception the use of spring dressings of nitrate of soda is advised.

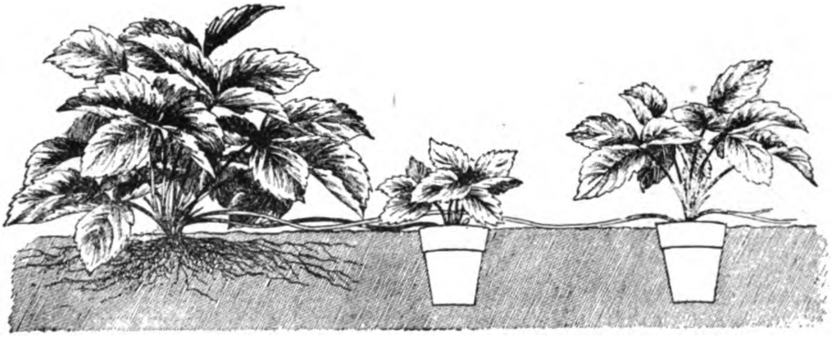


Fig. 326—YOUNG STRAWBERRY PLANTS LAYERED IN POTS

Transplanting—Strawberries are propagated chiefly from plants which are offsets from the mother plant. They should be chosen, when possible, from parents that have not been weakened by disease or by having borne a crop of fruit. North of Virginia early spring is the most satisfactory time for setting out the strawberry bed. In some portions of the South late summer and fall settings produce satisfactory results. With spring planting in the North the plants become well established during the summer and produce a profitable crop of fruit the following spring. Fall planting in August will give a small crop of berries the following spring. By layering the first runners in small pots, as seen in Fig. 326, much better results may be obtained. A well-grown potted strawberry plant is seen in Fig. 327.

Sets used for planting out should have the roots cut back 1-3. They must be kept moist and away from drying winds. A hole is made with a dibble or trowel deep enough to put in the plants without doubling up the roots. The roots should be spread out fan-shape and the soil compacted firmly about them. The crown of the plant should set just level with the surface of the ground. If set too deep it will rot.

Fig. 327—POT-GROWN STRAWBERRY PLANT

Strawberries are set either in hills or rows. On a small scale the hill method is satisfactory, but commercial growers generally plant in matted rows. If hills are used they should be about 3 feet apart one way and 12 to 15 inches apart the other. By the matted row system the rows are generally 4 feet apart and the plants set 18 to 24 inches distant in the row. The runners from these plants are then allowed to set plants freely at a distance of 6 inches to a foot either side the row, thus making a mat of plants from 1 foot to 2 feet wide. Matted rows about 18 inches wide are most popular. Heavier yields are secured with matted rows than with hills. Spring set plants should not be allowed to bear fruit, but should be kept well cultivated throughout the season.

Mulching—Strawberries are usually mulched. The mulch is used to protect the plants from alternate winter freezing and thawing, to retard the blossoming period in spring and to protect the immature fruits from late frosts. In the South the principal use of the mulch is to keep the fruit clean. Straw, stable manure, marsh hay, pine needles and such materials are used. Marsh hay is perhaps the best material, since it is free from weed seed. The mulch should be placed 3 or 4 inches deep between the rows, but only lightly cover the plants. If the plants are covered too deep or the mulch is allowed to stay on too long in the spring the plants will bleach and weaken and suffer when uncovered and exposed to either sun or frost. On poor lands a mulch of well-rotted barnyard manure is most desirable. Mulching is especially desirable on clay soils. It should be deferred in the fall until the ground is frozen. In Mississippi the station recommends the application of 2½ to 3 tons of cottonseed hulls per acre around the plants in February. At the New York Cornell Station the blooming and fruiting periods were delayed from 10 days to 2 weeks by mulching. The average is about 1 week.

As the strawberry plants start to grow in the spring the mulch should be removed from over the plants to the middle of the rows. If the mulch is of pine needles or some fine material the plants will push up through it, leaving it in place to protect the fruit from the soil. If frost threatens at a critical period after the mulch is removed the crop can often be saved by putting it back over the plants. At an outlay of $8 for the labor in replacing the mulch when frost threatened at the Wisconsin Station a crop of berries worth $300 per acre was saved.

Treatment of Beds After Harvesting—Commercial strawberry plantations should seldom be fruited more than 2 seasons. Insects, weeds and diseases usually come in by this time and make it more profitable to start new beds than to clean out the old. In the home garden the same bed is generally fruited a number of seasons. The experiments at the stations show that in general, with spring set plants, the largest berries and berries of most uniform grade and quality are obtained the first season after planting; while the earliest fruit and heaviest yield of fruit are obtained the second season. Where the strawberry bed is fruited for 2 or more seasons it is advisable to mow it after the berries have been picked and burn it over. This practice is one of the most effective means of destroying insects and fungous diseases.

After the bed has been burned over there are several methods of putting it in shape for the following season. At the Minnesota Station a furrow is plowed on each side of the matted row and filled with well-rotted barnyard manure. The cultivator is then set going and all the weeds and old plants in the row cut out with a hoe and the other plants thinned where needed. This general plan is observed at a number of stations with variations of details. Sometimes in the case of a wide matted row all the plants are plowed up except a strip 8 to 10 inches wide on one side of the row. This leaves practically only 1-year-old plants in the row, thus renewing the bed each year.

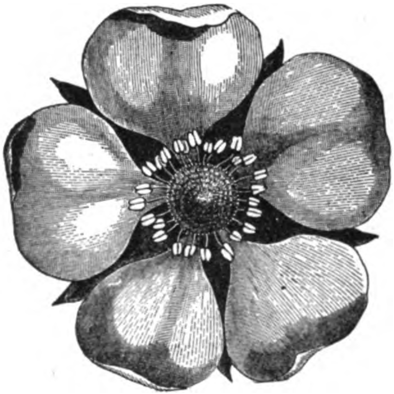


Fig. 328—STAMINATE OR "PERFECT" STRAWBERRY FLOWER

Irrigation—Strawberry plants, especially at the time of fruiting, require an abundance of water. In Colorado the station advises that newly set beds be irrigated about once every 2 weeks and cultivation continued up till frost comes. Just before freezing weather sets in the plants should be well irrigated. Fruiting beds on sandy soil require irrigation twice a week, while on clay soils once a week is believed to be sufficient. The Kansas Station found that a given quantity of water was much more effective when the plants were fruiting if it was showered directly on the plants instead of letting it run down between the rows in the usual way. The showering should always be done in the afternoon and evening. In many of the humid States of the East the yield of strawberries has been doubled and trebled by timely application of water during the fruiting season.

Varieties—Some of the best varieties of strawberries have "imperfect" blossoms; that is, blossoms which do not bear pollen. If these strawberries are set out alone they will bear no fruit whatever. If a few plants flowering at the same time and producing an abundance of pollen are mixed with them then they bear heavy crops of berries. Other varieties have "perfect" flowers and are capable of fertilizing themselves and of producing fruit when planted alone. It is a matter, therefore, of the utmost importance that the planter know beforehand whether the varieties he is to grow are "perfect" or "imperfect." Flowers of each type are seen in Figs. 328 and 329.

The station experiments show that, on the whole, these 2 classes of berries are equally productive, and that the frost resistance of the imperfect varieties is a little greater than that of the perfect ones. In the strawberry plantation at least every third row should be set with a perfect variety.

No specific recommendations as to varieties best suited to different localities can be given, but for market purposes, according to the Michigan Station, it is probable that there are no more profitable varieties than Bubach, Haverland and Warfield, with Bedderwood, Sharpless or Clyde as pollenizers for these "imperfect" varieties. Practically every experiment station has published the results of variety tests of strawberries in bulletin form. (See *Agricultural Experiment Stations* for address.)

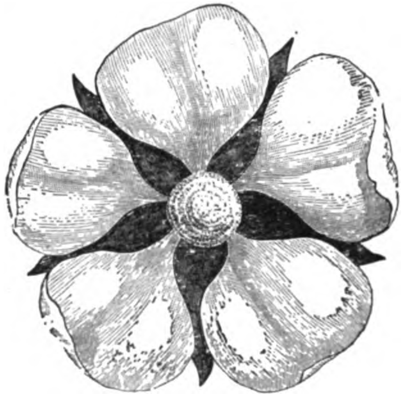


Fig. 329—PISTILLATE OR "IMPERFECT" STRAWBERRY FLOWER

Enemies: Powdery Mildew (*Sphaerotheca castagnei*) is recognized by a curling of the leaves into a cup form. The under side of the leaves is covered with a frost-like growth. It occasionally attacks the fruit, rendering them insipid. The disease may be controlled by spraying with Bordeaux mixture or dusting the plants with sulphur.

Leaf Spot or Rust (*Sphaerella fragariae*) (Fig. 330) produces red, black-bordered spots on the leaves soon after the berries are gathered. The spots may, however, appear much earlier. The edges are often purple. After harvest the leaves should be mowed off and burned. Repeated applications of Bordeaux mixture, except during the berry season, will hold the disease in check. When strawberry patches become badly infested with fungous diseases or insect pests much good is done by mowing off the plants and burning the ground over after harvest.

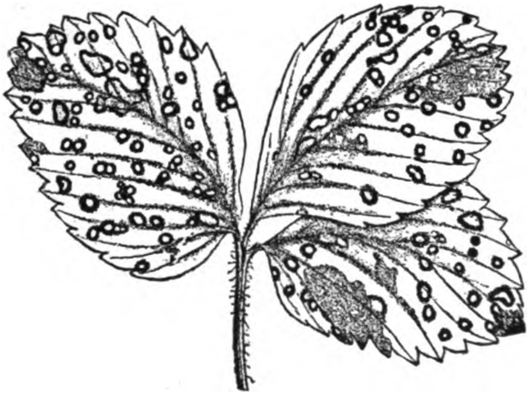


Fig. 330—STRAWBERRY LEAF BLIGHT

Strawberries are also attacked by leaf blotch, another form of leaf spot. These diseases yield to the treatment just recommended.

In Massachusetts a bacterial blight has been observed which causes the plants to turn brown and dry up. The disease is apparently unable to gain entrance to vigorous plants.

Crown Borer (*Tyloderma fragariae*) in the larval stage is a white, footless grub, 1 inch in length, with a yellow head. The adult is a brown beetle similar to the plum curculio. The eggs are laid in the crown of the plant and the larva upon hatching burrows in the crown and emerges in the fall to hibernate in the ground. Old plants are most seriously attacked, and such patches should be mowed and burned over after the berries are harvested. In case of serious infestation, rotation of crops is to be followed.

Crown Girdler (*Otiorrhynchus ovatus*) is a small pink or white footless grub, which girdles the crown of strawberry plants in May or June. The adult is a small brownish-black snout beetle, which appears in April or May, and is probably single brooded. The beetle feeds on a considerable variety of cultivated plants. It is wingless and its distribution is therefore slow. Infested fields should be plowed when the larvae are only partly developed, and plants from such fields should not be used for a new plantation.

Leaf Roller (*Phoxopteris comptana*) is a brown moth, ½ inch across the wings. It appears in early spring and deposits eggs on the leaves of strawberry, raspberry and blackberry. The larvae are greenish-brown and become full grown in June, after spinning a web and rolling the leaves together in a characteristic manner. There are 2 or more broods annually. This insect may be destroyed by spraying with arsenate of lead, 15 ounces to 80 gallons of water, in May, or with Paris green, 1 pound to 150 gallons of water. Strawberry plants should be mowed down and burned immediately after picking.

Thrips (*T. tritici*) is a minute yellow insect, with an orange tint on the thorax. The species is most injurious in the Southern States, where it attacks the pistils of strawberries, causing a blighting of the ovaries. Other parts of the flower are also attacked to some extent as well as the foliage. This insect is also injurious to a considerable variety of fruit trees and garden crops. Good success has been had from spraying with Rose Leaf Insecticide, whale-oil soap or kerosene emulsion. The latter 2 remedies must not be used too near the berry season, on account of the liability to impart a disagreeable flavor.

Weevil (*Anthonomus signatus*) is a small black snout beetle, which attacks strawberries as soon as the buds appear in the spring. The chief injury is done to the buds and blossoms of perfect flowering varieties. The larva enters the center of the blossom and prevents its development. This insect may be largely controlled by spraying with arsenical poisons in the spring, when the flower buds begin to appear.

Tarnished Plant Bug (*Lygus pratensis*) varies in color from dark yellow to nearly black. It is a bug about ¼ of an inch long, which sucks the juice from a great variety of growing plants. It is injurious in both the adult and immature stages. This species may be destroyed by dusting infested plants with pyrethrum or by spraying with kerosene emulsion.

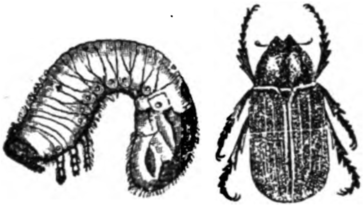


Fig. 331—WHITE GRUB AND BEETLE

White Grubs—These are the larvae of May beetles (*Lachnosterna fusca,* etc.) The adults, also known as June bugs, are recognized by their brown or black color and their habit of flying to lights at night. The common species is about ¾ of an inch long. They remain concealed during the day and come out at night to feed on the leaves of trees. The eggs are laid in the ground and the larval existence extends over 3 years. The grubs are soft, white, with a brown head. The grub and beetle are seen in Fig. 331. There are many species of them but it is not necessary to the present purpose to describe them.

White grubs attack a great variety of plants but are especially injurious to grasses, cereals, fruit trees and bushes, nursery stock, and greenhouse plants. These pests are destroyed by parasitic fungi, mites, and other insects, and are fed upon by various birds and small mammals. The grubs may be destroyed by freezing of the soil and protracted drouth is unfavorable to their development.

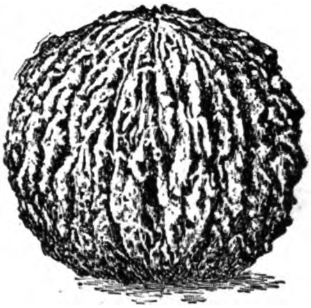


Fig. 332—BLACK WALNUT

The best insecticides for use against the grubs in the soil are bisulphid of carbon and kerosene emulsion. The use of fertilizers for this purpose has not yielded favorable results. Fruit and shade trees may be protected against the attacks of the beetles by spraying with arsenites, or the beetles may be jarred into catchers in the early morning. Rotation of crops is recommended. Thorough cultivation of the soil will destroy many of the grubs and expose them to birds and other enemies. In green-

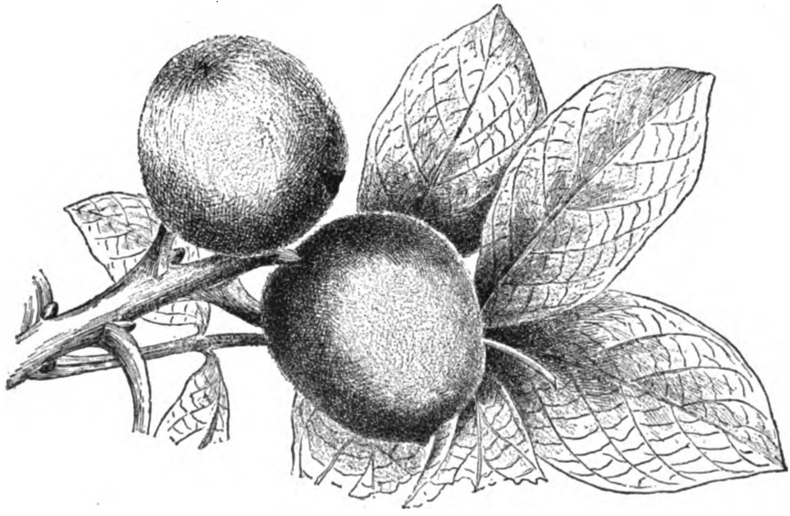


Fig. 333—BEARING BRANCH OF ENGLISH WALNUT

houses they may be destroyed by the use of poisoned bait, such as bran-arsenic mash.

ROOT LOUSE—See *Plant Lice* under *Cabbage.*

More than 50 species of insects have been reported as injurious to the strawberry, but those which have already been mentioned include the most important ones.

WALNUT

The 3 species of walnuts commonly grown in the United States are the black walnut (*Juglans nigra*), butternut (*J. cinerea*) and Persian or English walnut (*J. regia*). The black walnut and butternut are native forest trees, growing from 50 to 75 feet high and valuable as timber trees as well as for the nuts they furnish. These trees are seldom cultivated for their nuts. The wild nuts are gathered and marketed to some extent by farmers. The trees have been grown at a number of experiment stations in forest plantations. They grow quite rapidly, frequently acquiring a hight of 45 to 50 feet in 50 years, with a diameter of 8 to 10 inches. A black walnut with the husk removed is seen in Fig. 332.

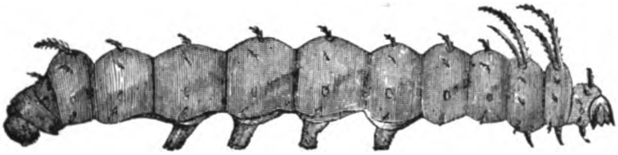


Fig. 334—LARVA OF REGAL WALNUT MOTH

The English walnut is a native of Persia. It is grown on a commercial scale in California for its nuts. In the East the tree is successfully grown as far north as New York, but it does not produce nuts in profitable quantities except in a few scattered localities. Walnuts are propagated from seed. Nuts for seed should be harvested soon after they have fallen and planted at once or stratified in moist sand, left outdoors over winter and planted in the spring. Varieties true to name are obtained by root grafting seedlings with the variety it is wished to propagate. The native nuts grow best on heavy loam or alluvial soils. They are frequently found in greatest perfection along river bottoms. In California the English walnut is most successfully grown on well-drained, deep alluvial soils, and makes only a stunted growth on clays or soils underlaid with hardpan. The trees are set in the orchard when 1 to 2 years old 50 feet apart each way. The orchards are kept thoroughly tilled and irrigated. The nuts mature about September 1, when they are gathered, bleached and sent to market. A bearing branch is seen in Fig. 333.

Enemies: BACTERIOSIS (*Pseudomonas Juglandis*) attacks the leaf, branch and nut, and may be recognized by the blackening of affected spots which are surrounded by a water-soaked band. Hard shell varieties are quite resistant and dormant trees may be protected by spraying with Bordeaux mixture.

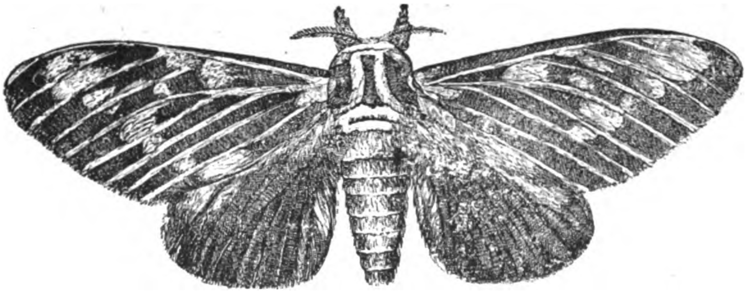


Fig. 335—REGAL WALNUT MOTH

TIGER MOTH (*Spilosoma Virginica*) is pure white, with a few small black dots on the wings. It measures 2 inches across the wings. The caterpillars are yellow, with a black head, and are covered with hairs. The caterpillar is often known as the "yellow bear," and feeds on the butternut, grapevine, currant and other plants. When it occurs in large numbers it may be readily destroyed by spraying with arsenical poisons. The butternut is also subject to the attacks of scale insects, borers and a number of leaf-eating insects, but these are seldom of economic importance.

WALNUT CATERPILLAR (*Datana angusii*) is the larva of a dark brown moth, with darker bands across the forewings, which have an expanse of nearly 2 inches. The eggs are laid in clusters on the terminal leaves, and the larvae devour all the leaf except the midrib. The caterpillars are gregarious, always feeding in clusters and migrating in colonies. When they undergo molting they crawl down upon the trunk and form a large mass. In this position they may be readily destroyed by crushing or by spraying with kerosene. Various birds feed upon the caterpillars, especially cuckoos and bluejays.

REGAL WALNUT MOTH (*Citheronia regalis*) is green, with yellow spots on the wings. The larva has 4 stout forked spines near the head, 2 at the posterior end. It feeds on the leaves of the walnut, hickory and persimmon. It may be destroyed by hand picking or by spraying with Paris green. The larva is seen in Fig. 334, the perfect moth in Fig. 335.

The walnut is also attacked by a large number of leaf-eating caterpillars, a weevil and several species of scale insects.

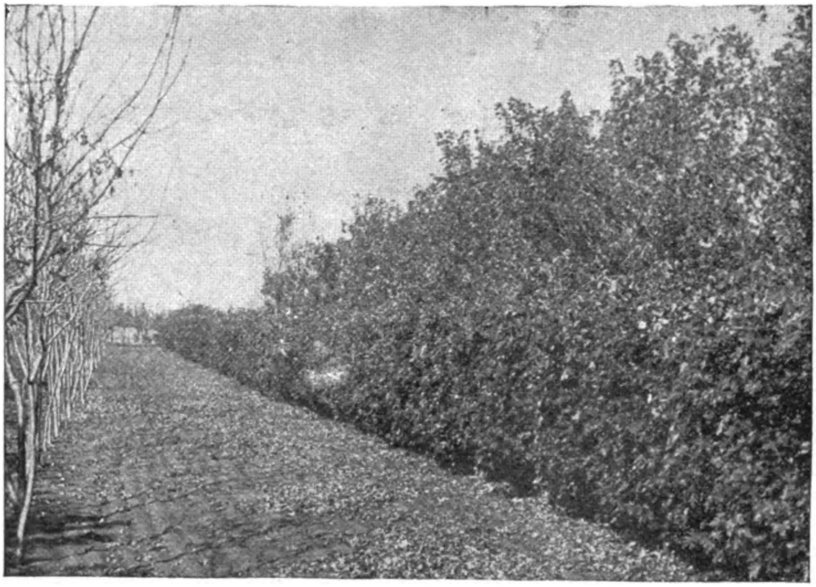


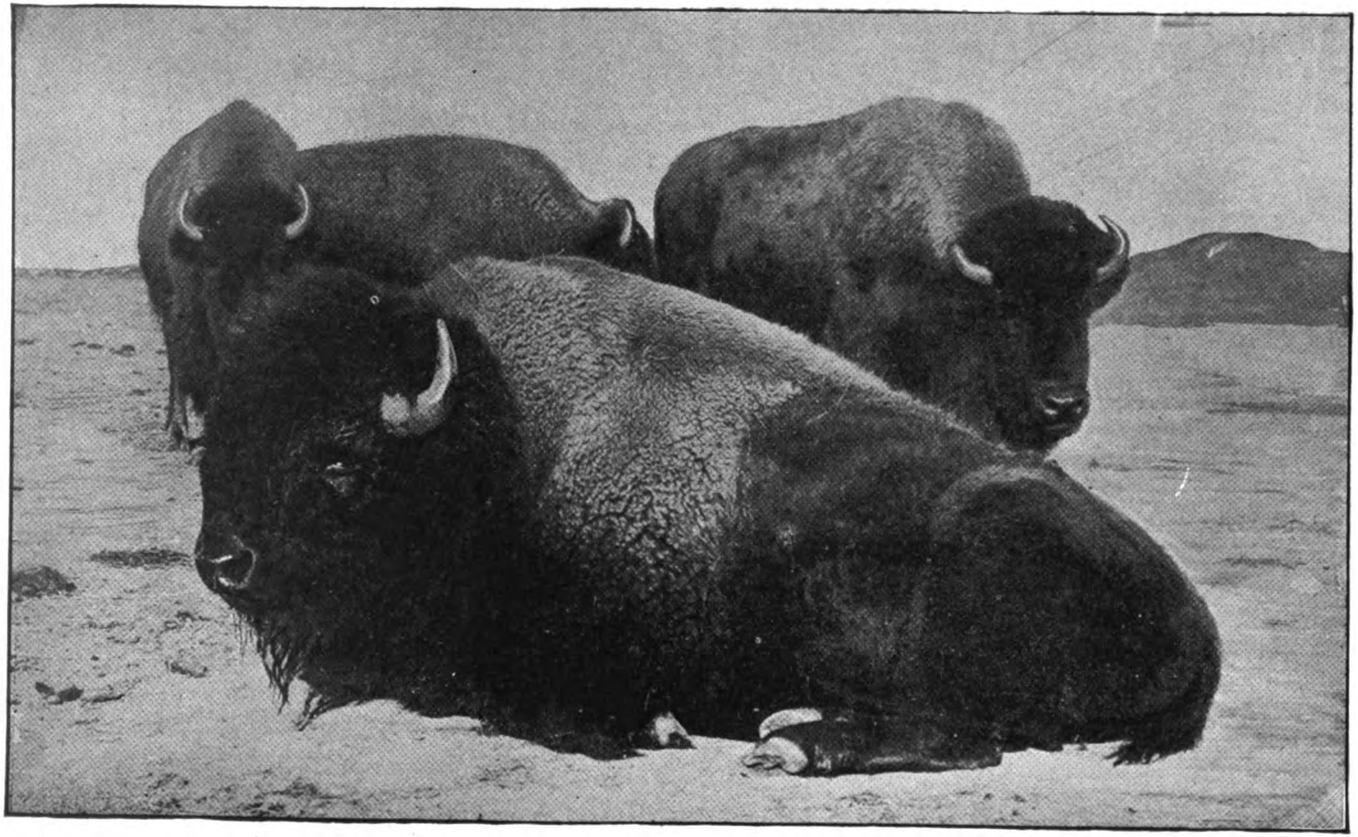
Fig. 336—MAPLE HEDGE WINDBREAK
(From N. D. Expt. Sta.)

WINDBREAKS

Shelter belts or windbreaks are terms applied to belts of shrubs or timber planted on the windward side of orchards, gardens or fields for the better protection of crops. They are of especial value in the prairie States, where high winds are more or less constant, but are often of much service elsewhere, particularly in orchard, small fruit and garden culture. The special uses of windbreaks are to break the force of strong winds, protect crops from cold and prevent evaporation of soil moisture. Windbreaks may be harmful when they are so dense as to hinder the circulation of warm winds through them or when they are made up of such plants as are especially likely to harbor injurious diseases. Ordinarily in the Northern States 1 or 2 rows of deciduous trees will afford sufficient protection. Any of the rapidly growing native trees may be selected for this purpose. Where the winters are severe or the prevailing winds are high thick evergreen screens may be highly beneficial. For this purpose the Norway spruce and Austrian and Scotch pines are especially valuable. The ideal shelter belt probably consists of a mixture of deciduous and evergreen trees. Effective windbreaks are seen in Fig. 336 and in the frontispiece.

PART IV

CATTLE AND DAIRYING



THE LAST CANADIAN BUFFALOES

FARMER'S CYCLOPEDIA OF AGRICULTURE

CATTLE AND DAIRYING

CATTLE

The importance of the cattle industry is too well understood to require any comment. According to the latest statistics the total number of cattle in the United States is 69,271,000. While cattle-raising constitutes an important part of agriculture in every State, the business is conducted on the most extensive scale in Texas, Iowa, Kansas, Nebraska, Illinois, Missouri, New York, Wisconsin, Ohio, mentioned in the order of their importance, and other States of the Western range region and Northern boundary.

All our domestic breeds of cattle are supposed to be derived by improvement and crossing from 2 original wild species of cattle. The breeds of cattle in the United States, with 1 exception (Fig. 337), were introduced from Europe, mostly from Great Britain.

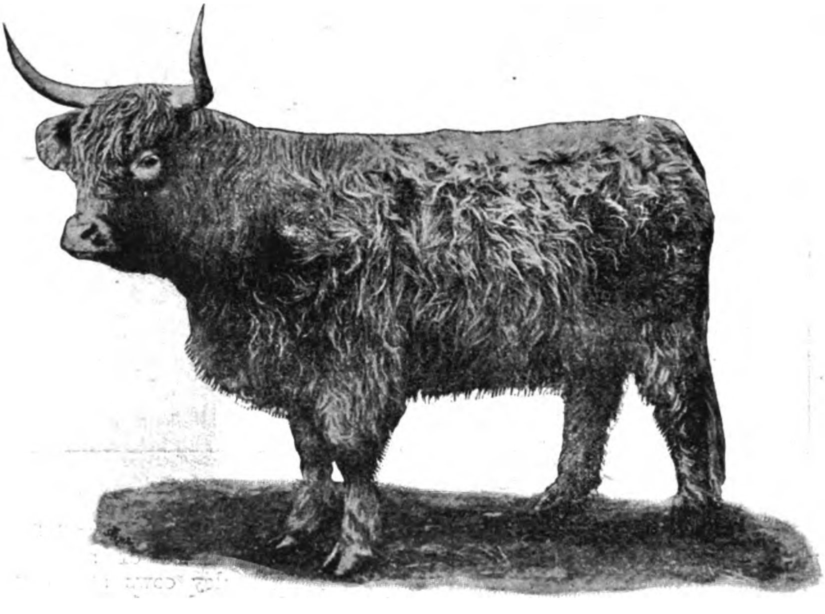


Fig. 338—TYPICAL WEST HIGHLAND HEIFER

Cattle are usually classified according to their form or conformation into 3 types: beef, dairy and dual-purpose. The general characteristics of the beef type are: compact form, medium length, wide, straight back, deep, full quarters. The outlines are those of a parallelogram and the form is rounded. The general outlines of the dairy cow form a wedge-like figure. The length is greater, the contour of the head and neck thinner, and the udder and milk vein well developed. The body is more angular and the temperament more nervous. The characteristics of the dual-purpose animal are intermediate between those of the beef and dairy types.

Breeds—The chief beef breeds in this country are Shorthorn, Hereford, Aberdeen-Angus, Galloway, Sussex and West Highland. (Fig. 338.) The principal dairy breeds are Ayrshire, Holstein, Jersey, Guernsey, Dutch Belted, French Canadian and Kerry. Among dual-purpose cattle the Shorthorns stand at the head. This class also includes Polled Durham, Red Poll, Devon and Brown Swiss.

A few of the chief beef and dual-purpose breeds may be briefly characterized here. For dairy breeds see under *Dairy Farming.*

SHORTHORNS, also called Durhams (Fig. 339), were brought from England to America about 1785. This is perhaps the most widely distributed and popular breed of cattle. Shorthorns readily adapt themselves to different conditions, are relatively large and mature early. They are good feeders, fair grazers, the meat is of excellent quality and the milk production is large. They have a large, rectangular, but smooth, symmetrical form. The color is red, roan or white. Red is preferred, while white is not in favor.

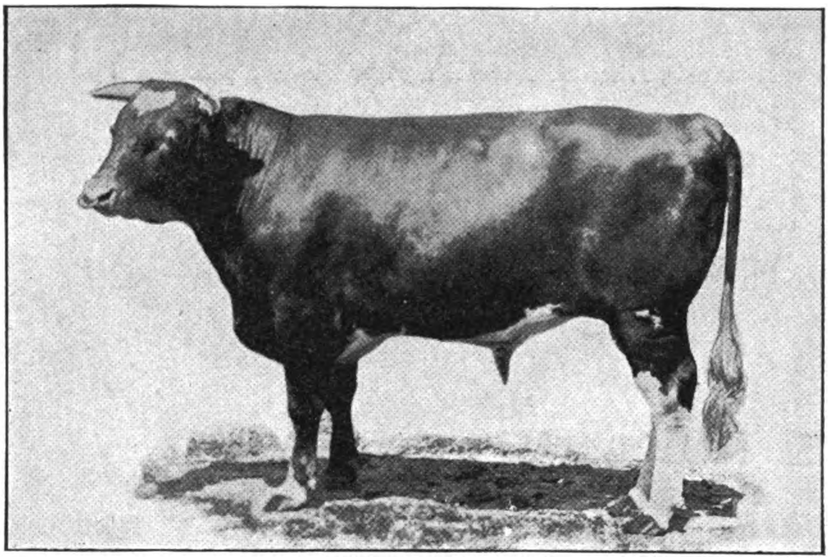


Fig. 339—SHORTHORN YEARLING BULL

HEREFORDS (Fig. 340) are believed to have been first imported into the United States by Henry Clay in 1817. They mature as early as the Shorthorns and are nearly as large. They are probably superior to Shorthorns in quality of meat and in grazing and breeding properties. They are nearly equal in adaptability, but produce less milk than Shorthorns. The ground color is a rich red, with white face, legs, under part of the body and tip of the tail. They have lighter thighs, thicker skin, more spreading horns and more curly coats than the Shorthorns.

The ABERDEEN-ANGUS (Fig. 341) originated in Scotland and was first brought to the United States in 1873. They are raised most extensively in Iowa and Illinois. The breed is growing in popularity. They are perhaps not so well adapted to range conditions as the Shorthorns. They are but little smaller than the latter and mature almost as early (at about 30 months). They are good feeders and the quality of meat is superior to that of Shorthorns or Herefords. Their milking properties are somewhat inferior.

The POLLED DURHAMS (Fig. 342) have been developed in Ohio and other neighboring States within the past 30 years. They have 2 lines of ancestry, one bred from muley cows and Shorthorn bulls, and the other from pure Shorthorns, which were hornless. They are, in fact, hornless Shorthorns, and their leading characteristics are the same as those of Shorthorns, except that they are polled and better milkers.

The DEVON (Fig. 343) is one of the oldest breeds of English cattle and was first brought to America in 1817. Devons are inferior to Shorthorns in size, adaptability, maturing and feeding qualities. They are about equal as milkers and the quality of the meat is very superior. They are of active habits and are good grazers. The general color varies from a rich red to a pale chestnut, with no black or white except a white spot on or in front of the udder. The horns on the female are slender, creamy white and curved upward. The milk is very rich, but the quantity is small. The dates given for the importation of this and other breeds are those of the first introduction of a herd to which records can be traced in this country. Undoubtedly earlier importations were made.

Feeding Qualities of Different Breeds—It is generally believed that so-called beef breeds are better for beef production than dairy breeds or scrubs. The reasons given for this superiority, however, are often incorrect. A comparison of breeds at the Michigan Station showed no constant differences in meat production among beef breeds. Dairy breeds made poorer gains, laid on more fat around the internal organs, showed more shrinkage and a higher percentage of cheap parts than beef breeds. The latter also matured earlier. In Missouri the Shorthorns stood first in power of beef production and in quantity of fat. Angus was first in palatability of meat and in all around excellence, followed by Shorthorns, grades and Herefords. All the pure breeds and grades proved better than scrubs. In North Carolina, however, scrubs proved more profitable than grades on cottonseed meal and hulls. At the Minnesota Station no constant differences were found in the fattening qualities of grades from different breeds. Angus and Shorthorns proved equally good at the Iowa Station. In Kansas, Shorthorns were slightly superior to scrubs in economy of gain and percentage of dressed weight. Native steers did better than pure breeds in Utah. At Toronto no differences were noted in beef qualities of pure breeds, but good grades made better gains than scrubs. Holsteins proved superior to Shorthorns and Herefords in Maine.

The experimental comparison thus fails to show that 100 pounds of gain can be produced with less feed by beef breeds than by dairy breeds, grades or even scrubs. Nevertheless, there are good and sufficient reasons for choosing beef breeds for the production of beef. Beef breeds lay on fat in the best cuts of steak and roasts on the back (Fig. 344), while the dairy breeds accumulate fat around the internal organs. Tallow may constitute as much as 32 per cent of the carcass of a Jersey steer. The contour of such animals remains angular when they are fattened and they bring a smaller price on the market.

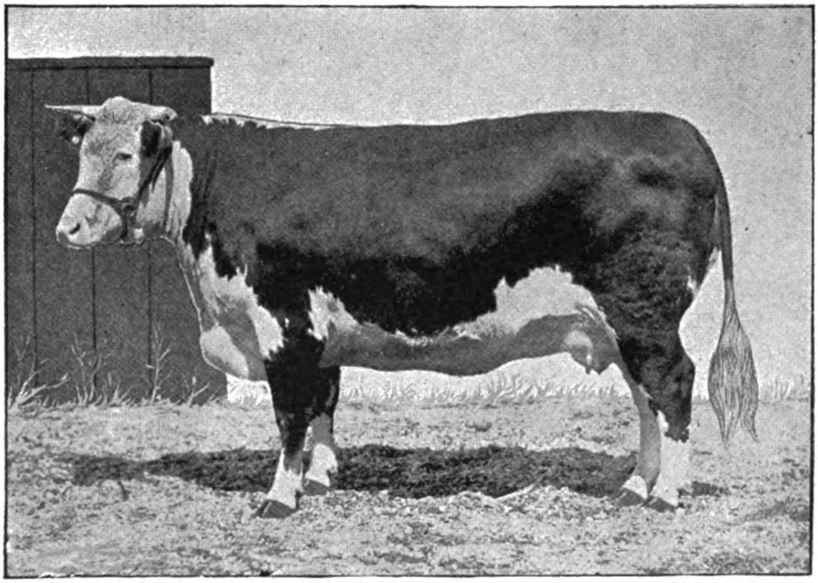


Fig. 340—HEREFORD COW

Period of Gestation and Other Physiological Data—The average duration of pregnancy in cows is 285 days, the extremes being 240 and 336 days. Bull calves are usually carried a few days longer than heifers. In young heifers and very old cows the period is often shorter than the average. At the Maine Station the average was found to be 282 days for bull and heifer calves. The weight of calves at birth varies from 50 to 130 pounds. At the Maine Station the average weight was found to be 73.6 pounds, the average weight of bull calves being 76.8 pounds, and of heifers 70.1 pounds.

Much speculation has been indulged in concerning the factors which determine sex, and numerous theories have been proposed, which cannot be discussed here. Suffice it to say that none is perfectly satisfactory. At the Maine Station 82 cows served during the first part of heat produced 31 bulls and 51 heifers, and 76 cows served in the last part of heat produced 42 bull and 34 heifer calves. There are other experiments at variance with these results, and no conclusions can be drawn regarding the influence of the time of service upon the determination of sex. Statistics compiled on 3614 calves do not substantiate any theory of sex determination. Some cows show a tendency to produce bull calves, others heifers and still others twins. Of 3614 calves 62 were twins.

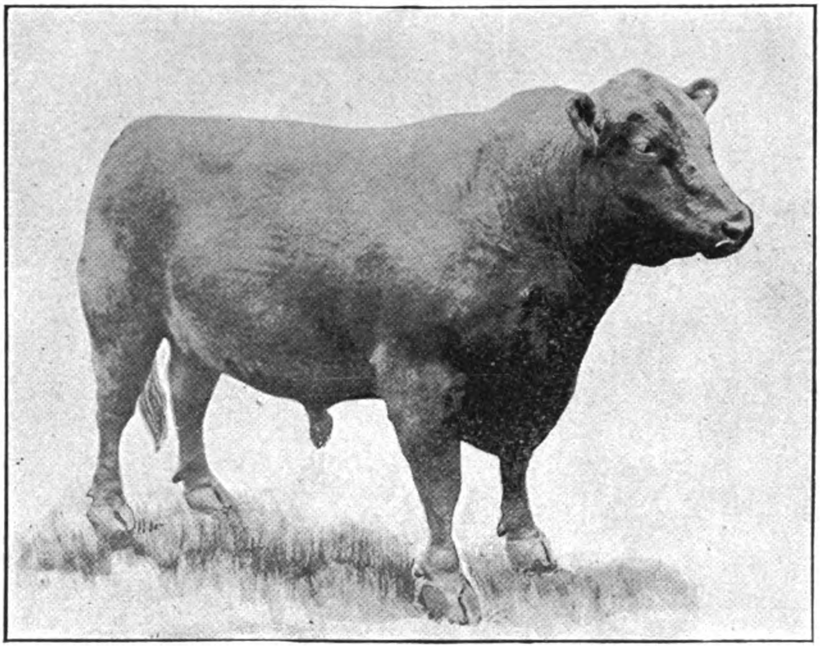


Fig. 341—ABERDEEN-ANGUS BULL
(Breeder's Gazette)

The normal temperature of adult cattle is 101° to 102° F. It may be somewhat elevated by exercise or lowered by large drafts of cold water or exposure to cold. Fever temperatures in cattle range from 103½° to 106° F., or higher. The temperature should be taken by inserting a thermometer into the rectum and allowing it to remain for 3 to 5 minutes. The pulse rate is 45 to 50 times per minute.

Calves—Several systems of raising calves are in vogue among different stockmen. The calves may be allowed to run with the cows and suck at will. They may be confined and allowed to suck 2 or 3 times per day. In this system 1 calf may be allowed to suck 1 or 2 cows, or 2 calves may be allowed to suck the same cow, according to the flow of milk and size of the calves. Calves may also be confined and fed fresh whole milk from the pail. Again they may be fed on fresh sweet skimmilk or separator milk or on sour skimmilk, or even buttermilk or whey.

On the Western ranges and in other localities where beef is the chief object and where the milk is not desired for other purposes, the calf is allowed to run with its mother. Under range conditions this is the only possible economic way of raising calves. The sucking calf develops into a more promising yearling than the skimmilk calf, especially if the latter is fed in a careless and irregular manner. Without proper care skimmilk calves make small, pot-bellied yearlings, which in the Western States are known as "dogies."

Wherever cattle are raised on a small scale and there is a good market for milk, it does not pay to let calves suck the cows. Only calves which will bring fancy prices for breeding purposes can profitably be allowed to run with the mother. Milk will bring a larger price as butter than ordinary calves can make from it.

The results of numerous experiments in the United States and Canada are in substantial agreement with regard to the most economic method of raising calves. They should be allowed to suck the cows for 3 or 4 days. They will thus get the colostrum or first milk and exercise a favorable influence in preventing inflammation of the udder. About the fourth day the calves should be separated from the cows and fed on whole milk by means of an artificial feeder, or taught to drink whole milk from a pail. As soon as they have learned to drink the whole milk should be gradually replaced with warm, sweet skimmilk, so that the calves are receiving nothing but skimmilk at the end of 4 weeks. The skimmilk should be fed sweet and warm (95° to 100° F.). The change from whole milk to skimmilk should cover a period of about 2 weeks. The skimmilk ration may begin at 10 pounds per day and increase to 15 pounds at 4 weeks of age, after which it may range from 18 to 24 pounds.

Artificial feeders are usually unsatisfactory. It is better to teach calves to drink by using the fingers. Scouring in calves is usually due to feeding too much milk, or sour, cold or unclean milk. Careful attention should be given to these details. If scouring persists, the calves may be fed small quantities of wheat bran or rye bran, or a little lime may be added.

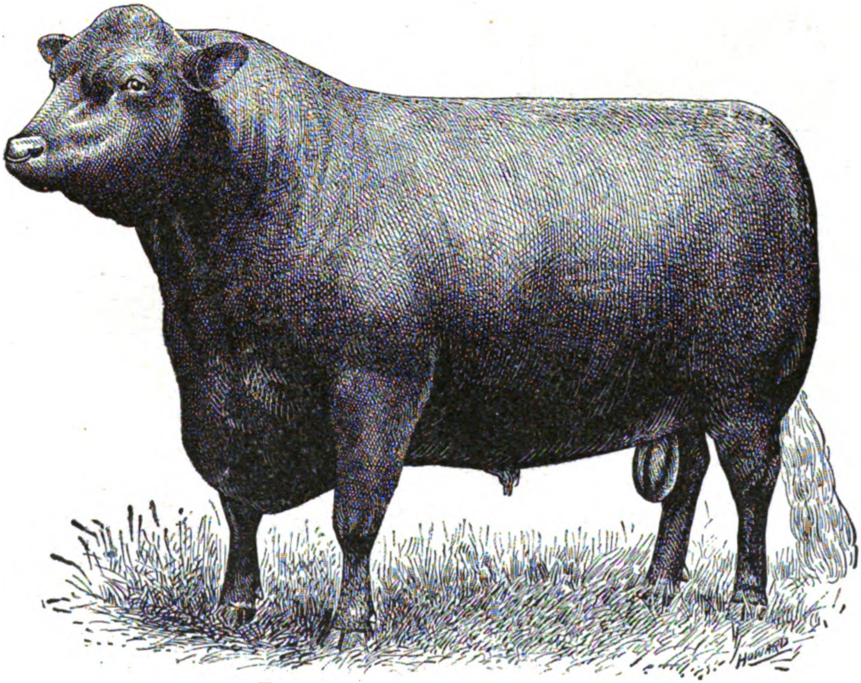


Fig. 342—POLLED DURHAM BULL
(U. S. Dept. Agr. Bureau of Animal Industry)

For their best development calves require milk for 4 or 5 months. After that time milk may be omitted from the ration. Small quantities of grain should be fed from the time the calves are 2 or 3 weeks old. Corn meal, Kafir corn meal, oatmeal and ground flaxseed or linseed meal are best for this purpose. Calves may be taught to eat by placing a handful of dry meal in the mouth.

At the Iowa Station the use of whole milk resulted in slightly better gains than skimmilk and flaxseed. The skimmilk calves, however, were less checked in their growth by weaning than were the whole milk calves. Cost of gain on full milk was 7.6 cents per pound, on skimmilk and flaxseed 5 cents per pound. In later tests corn meal proved best of all grains for this purpose. When fed dry after each feed of skimmilk it reduced the cost of gain to 2 cents per pound for a 90-day period. A little clover hay was fed at the same time.

At the Nebraska Station similar results were obtained. At the end of a year whole milk calves could not be distinguished from skimmilk calves, and the profits were much greater in the latter than in the former.

In Minnesota the cost of raising calves on whole milk was 3 times that of raising them on skimmilk and ground flaxseed. An emulsion of skimmilk and oleomargarine with the addition of brown sugar gave good results in Massachusetts. When pork was high and veal low, however, calves did not give as good returns from skimmilk as pigs. At the Indiana Station calves made profitable gains on skimmilk alone.

The Kansas Station recommends that skimmilk be sterilized at a temperature of 212° F. Calves which received 12 quarts skimmilk per day with a small quantity of dry Kafir corn meal made as good gains as on whole milk.

At the Pennsylvania Station milk gave better returns in veal than in butter. In Utah calves up to the age of 3½ months required less milk and grain for a pound of gain than pigs, but after 5 or 6 months they required more than pigs. In Wisconsin curds obtained from sweet skimmilk by heating it to 90° F. and adding liquid rennet extract gave excellent gains in calves. The Toronto Station found that skimmilk was no longer indispensable after 2 months.

In Mississippi cottonseed was found to be the cheapest grain for calves. If fed in too large quantities, however, it may kill them, as reported by the North Carolina Station.

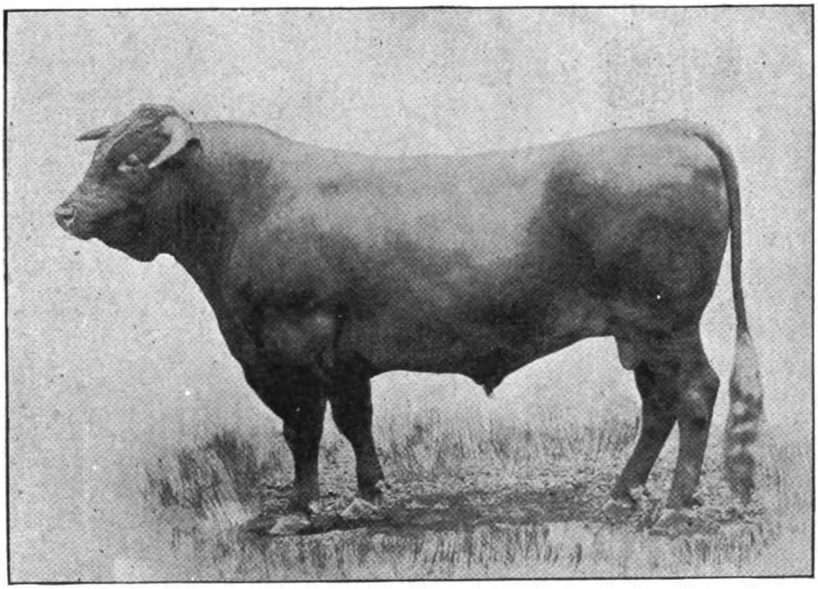


Fig. 343—DEVON BULL

This system of calf raising has been thoroughly worked out in Europe also. In France it was found that potato starch, cooked flaxseed, rice flour, barley meal, malt flour or oleomargarine could be added to a skimmilk ration with profit. Linseed meal proved superior to bran. Similar results were obtained in Holland, Sweden and other countries. In Sweden it was found that less diarrhea developed when an artificial feeder was used than when milk was fed from a pail. Recent experiments in Pennsylvania show that prime dairy calves can be raised without milk except for the first 2 weeks. A good milk substitute was found in a mixture containing wheat flour, cocoanut meal nutrium, linseed meal and dried blood.

Early Maturity, "Baby Beef"—Under certain circumstances, especially where dairying is combined with beef making, there is considerable advantage in securing early maturity or "baby beef." This problem has received much attention in Iowa, Kansas, Minnesota, Michigan, Wisconsin, Nebraska, Utah, New Hampshire, Colorado and Canada. The amount of feed required for a given gain is less in young than in old animals, and this fact often makes it desirable to begin forcing the animals from an early age. Scrubs do not mature so early as well-bred cattle and only the latter should be chosen for the production of baby beef.

The best plan for securing early maturity is to have the calves come in the fall. They may then be fed on skimmilk and grain until the pastures are green in the spring, when they should be turned to pasture with a daily grain ration. When the pasture gets short in the fall the calves may be taken up and forced on hay and grain to the age of 16 or 17 months.

In New Hampshire the total cost of bringing animals to a fine market condition at the age of 16 months was $28.81 per head. In Michigan it was found that early maturing breeds could perhaps be sold at most profit at 1 year of age if pushed from the start. In Colorado calves from 7 to 10 months of age were forced with good profit for 178 days on a ration containing corn, oats, sugar beets and hay. The Iowa, Nebraska and Minnesota Stations have shown that a combination of dairying and beef production may be made very profitable. Dairy Shorthorns give good returns in milk, and steers from these cows make the best of beef. After milk was withdrawn from the ration, corn gave better results than a ration of gluten meal, bran and linseed meal. After weaning a ration of alfalfa, corn meal and oats was found very effective. In Illinois corn silage proved better than shock corn in forcing baby beef.

It has been thoroughly demonstrated at the Minnesota, Iowa, Utah and Canadian Stations that, after weaning, calves may be maintained on a good growth ration of hay, silage and common farm grains, and then forced so as to be in market condition at 1 to 2 years of age. Better prices are thus obtained for farm crops than if sold directly. At the Canadian Stations baby beef was produced most cheaply on corn silage, with ground barley and peas, and linseed meal. Profits in baby beef from skimmilk calves were much greater than when whole milk was fed. When a forcing ration is given during the first year, the animals may not endure feeding a second year. Their health fails and there is financial loss. If forced from early life, calves should be finished off soon after the end of the first year or not later than 18 months. In Kansas skimmilk calves, fed alfalfa and corn for 7 months, proved to be as valuable for the production of baby beef as calves raised with the cows. "The farmer who raises and fattens mature steers has to furnish pasture for his cows, the yearlings, the 2-year-olds, and often for the 3-year-old steers. He waits 3 years from the time the calf is born until he realizes on the investment, and only one-fourth of his herd are cows producing calves. If the farmer will produce baby beef, he can fill his pasture to the full limit with cows producing calves, and he will realize on the calves 12 months from the date of their birth. Capital is turned annually instead of once in every 3 years. The farmer's grain will produce from 50 to 100 per cent more pounds of baby beef than it will of beef from a mature steer, and for the past 3 years the baby-beef animal has sold for as high prices per hundred as has the average steer.

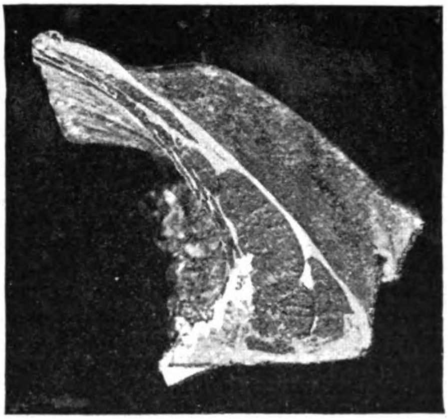


Fig. 344—CUT OF BEEF
(Tenn. Expt. Sta)

"In producing baby beef, the farmer can market his heifer calves at the same price as his steers, and will usually get more for the 12-months-old heifer than he would for the same animal if kept until maturity." (Kan. Expt. Sta. Bul. 113.)

In raising calves for dairy or breeding purposes or for the production of mature beef at the age of 3 years or older, the same general plan of feeding should be adopted as outlined above, except that after weaning, the calves should not be forced, but should be fed so as to gain 1 to 1¼ pounds per day after 4 months of age.

If calves are to be fed for veal they should be forced from the start on milk and grain. In some markets the top prices are obtained only for calves which have been fed exclusively on whole milk. In Europe this plan is generally adopted and calves are muzzled to prevent them from eating straw or bedding. They are given a little chalk or ground shells to prevent scouring.

Fattening Steers: CONDITIONS AFFECTING THE GAINS, STEERS VS. HEIFERS—At the Iowa station a comparison was made between steers and heifers, spayed and unspayed, with reference to their beef qualities. Spaying temporarily retarded growth. Steers gave the largest profits, unspayed heifers the least. The percentage of dressed weight was about the same in all. The heifers gave more rib and loin cuts than the steers. In later tests spaying was found of little if any benefit and heifers gave more profitable carcasses on the block than steers. The cost of feeding and rate of gain were practically the same for steers and heifers. There is a prejudice in many markets in favor of steers even when heifer carcasses are of better appearance.

SHELTER—The results of comparison of indoor and outdoor feeding do not show any great uniformity. Range steers, or any steers which are not accustomed to being handled, are more or less worried by confinement and may fail to make satisfactory gains. Such animals do best when given the liberty of yards with accessible shelter. Steers generally eat more in yards than in stalls. In winter more feed may be required for a given gain in outdoor feeding than in warm barns. Many experiments have shown no difference in favor of either indoor or outdoor feeding. Comparisons of feeding in box stalls and stanchions are mostly in favor of box stalls. Only gentle or dehorned animals should be turned together in box stalls. In Nebraska, steers fed in box stalls made better gains than those in open sheds. In Minnesota more economical gains were made in open sheds than in stables. The cost of providing barns and sheds will largely determine the question with different stockmen. As a rule a certain amount of exercise seems necessary to the best results in fattening, especially if the period is long, but shelter should be accessible so that the cattle may not suffer from severe storms.

RANGE CONDITIONS AND RANGE STEERS (Fig. 345)—It is a matter of common knowledge that the day of the old cattle kings is rapidly disappearing. The Western ranges, however, still produce a large percentage of the cattle which serve as feeders for the big cattle markets. In former years no attempt was made to feed or shelter range cattle in winter. Now the majority of cattle ranchers raise forage for winter feeding. The estimated cost of running cattle on the range is $2 to $4 per head per year. One bull is allowed to every 25-50 cows. It is not considered desirable that range heifers should have calves until they are 2 or 3 years old. A certain percentage of cows are barren or abort, but about 80 per cent of range cows should drop calves.

At the Iowa Station it was found that range steers could not be bought and fed with as much profit as may be obtained from a herd bred for the purpose of combining dairying and beef making on the same farm. Range steers vary exceedingly in their fattening qualities and in the profit which they return. If they are wild or of sullen disposition they make poor gains. They cannot be fed an excessively large grain ration and cannot be forced for a long period with profit. At the Minnesota Station it was found that range steers weighing 1200 pounds could be brought to good condition within 130 days on 9 pounds of mixed meal daily (bran, barley, corn and linseed meal) with silage and hay. Beef was thus produced at a cost of 3.8 cents per pound. A number of large companies have for years been engaged in the business of feeding range cattle. During the 11 years from 1886 to 1897 the Standard Cattle Company fed 49,648 cattle from 4 to 5 years of age. The average length of the feeding period was 186 days, the average weight at the beginning of the feeding 1036 pounds, at the close 1260, the average daily gain

1.2 pounds, the average daily grain ration 16.7 pounds, and the average daily hay ration 12 pounds. In the 3 years from 1894 to 1897 the cost of 100 pounds of gain varied from $6.33 to $12.60.

Age and Gains—The amount of feed required for a pound of gain increases with the age of the animals. The cost of gain also increases in the same proportion, while the rate of gain decreases as the animals grow older. In young calves a pound of gain has been produced for each 1½ to 2 pounds of dry matter fed. The required amount gradually increases until adult age, when from 10 to 12 pounds of dry matter are consumed for each pound of gain. The same law holds true for sheep and pigs.

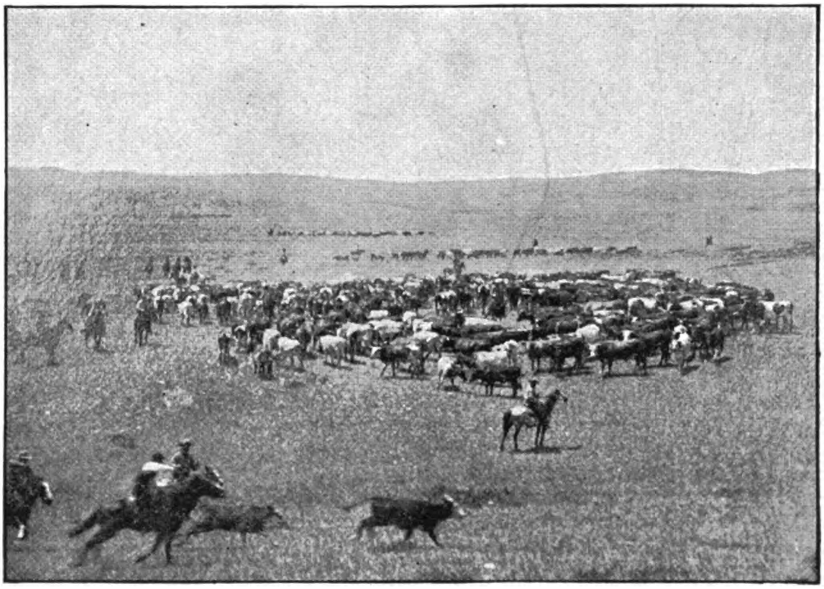


Fig. 345—ROUND-UP IN WYOMING

In Alabama 18-year-old oxen were fed at a loss, while young steers made good gains on the same feeding stuffs. At the Maryland Station it was found that dairy cows 6 years old or less could be fattened at a fair profit, while cows 8 to 10 or more years old were fed at a loss. Work oxen 6 years old were fattened at a good profit. In Colorado, Oklahoma, North Carolina and other States, as well as in Canada, more profit was found in 2-year-old than in 3-year-old steers. At the Ottawa Station the cost of 100 pounds of gain was as follows: In calves $4.89, in yearlings $7.23, in 2-year-olds $7.45, and in 3-year-olds $13.75.

The following table, prepared from results obtained in American and foreign experiments, indicates the influence of the age of the animal upon the rate of gain:

Age of cattle in y'rs	Av. age y'rs	No. of localities	No. of trials	No. of animals	Av. g'n p. day in lbs.
1-3 to 1	½	4	19	70	2.30
1 to 2	1¼	12	41	361	2.09
2 to 3	2½	16	50	506	1.58
3 to 4	3½	7	27	208	1.44
4 to 5	4½	2	13	49,654	1.20

The majority of the 4-year-olds in the above table were fed by the Standard Cattle Company. The figures for the other ages are compiled from experiments in such a variety of localities and with such a variety of feeding stuffs that we may safely assume considerable reliability for the accuracy of the average daily gains indicated for the different ages.

At the Colorado Station the following results were obtained by feeding steers of different ages on alfalfa hay:

Age of steers	Hay eaten d'ly in lbs.	Hay required for 100 lbs. g'n	Daily g'n in lbs.
4.6	32	3,600	1.00
2.3	21	1,300	1.70
1.4	19	900	2.20

Length of Feeding Period and Gains—In general the longer the fattening period the larger the amount of feed required for a given gain. At the Kansas Station it was found that for a feeding period of 56 days 730 pounds of grain made 100 pounds of gain, while for a period of 182 days 1000 pounds of grain were required for the same gain. In some animals it cost 4 times as much to produce a pound of gain at the end as in the beginning of the feeding period. Forced feeding, especially for long periods, is an unnatural process. There is a limit in all cases to the amount of fat which an animal can be made to lay on. Nature may then protest by failure of appetite, lessened ability to make good use of food, or in other ways against a continuation of the forcing process. When cattle reach a good market condition they should be promptly sold. The last few pounds of gain are very expensive.

Effect of Dehorning—At the various stations where dehorning has been tested it caused a loss of 7 to 50 pounds in weight per head. Steers required from 5 days to 2 weeks to regain their original weight. The check in growth of steers due to dehorning is therefore not a serious matter. If range steers or animals with an ugly disposition are to be fed in confinement with safety they must be previously dehorned.

Grains for Steers—Cattle cannot be successfully fattened without the liberal use of grain in the rations. The value of the grains which are commonly fed to cattle may be discussed at this point.

CORN, for the greater portion of the country, unquestionably stands at the head of the list of grains for economy and effectiveness in beef production. It may be fed as the only grain in the ration in feeds of from 4 to 18 pounds per day, but better results are usually obtained when small amounts of cottonseed meal, linseed meal, barley, wheat or peas are fed with the corn.

At the Colorado Station corn and wheat appeared to be about equally effective, but on shipping the shrinkage was much less in the corn-fed steers. The latter were also far ahead of those fed on barley with or without sugar beets. Corn proved slightly superior to Kafir corn in Oklahoma and about equal in feeding value to wheat meal in Ohio. In Pennsylvania corn showed a higher feeding value than wheat. In Virginia corn, either whole or ground, made greater and cheaper gains than cottonseed products, the cheapest gains being made on whole corn (12 pounds per day), with hay and silage. In Texas corn chops proved more profitable when used during the whole feeding period than when used to finish off steers which had been fed on cottonseed products. Gluten meal was found superior to linseed meal in Ohio. In Illinois gluten meal produced the required market finish in steers most cheaply of several rations tested.

Many experiments have been made to determine the relative value of dry and soaked corn and to compare unhusked ears, corn in the ear, whole shelled corn and corn meal. At the Kansas Station less corn was found in the droppings of steers when the corn was fed soaked than when fed dry. If it costs more than 6 cents per bushel to soak the corn it will not pay. Where the stock grower raises his own corn he cannot afford to expend any labor on it after it is matured. It should be fed in the ear without husking. In that form it is about as effective as corn meal, and the cost of husking, handling and grinding is saved. If hogs are allowed to follow steers in the feed lot all the undigested corn is utilized by the hogs. (See under *Swine.*) In Iowa the use of whole corn resulted in cheaper gains than corn and cob meal. In one test at the Kansas Station whole corn proved equal to corn meal, in another slightly inferior. About 15 per cent of the whole corn was passed in the manure and 6½ per cent of the corn meal. All of the former and practically none of the latter can be utilized by pigs. At the Minnesota Station it was found that steers would eat much more corn meal than they could digest, and it was thus wasted. Corn meal fed to steers at pasture did not give profitable returns. The meal was apparently carried out of the alimentary tract by the green feed before it was digested. The economy of feeding corn whole is also shown by experiments in Wisconsin. At the Texas Station a considerable saving was made by feeding corn, cob and husk coarsely ground together.

BARLEY, especially the bald variety, may be fed as the only grain or in combination with other grains. At the Montana Station barley gave profitable returns when fed to steers with alfalfa or clover. It was found that ¾ pound barley per day for each 100 pounds live weight of the steers was sufficient to produce good gains. In North Dakota barley gave greater and faster but more expensive gains than bran and shorts. In Utah barley was found to be cheaper and more effective than pea meal for steers. Barley produced nearly as rapid gains as corn in Colorado, but shrinkage in shipping was greater. In Scotland barley bran produced more profitable gains than linseed or cottonseed meal. In Germany excessive feeding of the distillery refuse of barley and other grains had an unfavorable effect on the quality of beef. At the Woburn Experiment Farms it was found that dried brewers' grains could not be profitably used to replace all the hay in a ration for steers. When replacing a part of the hay they made rapid gains.

Beans have been but slightly tested in feeding experiments with steers, although they are fed to a considerable extent. "Jack bean" meal was not relished by steers in Mississippi and proved to be very indigestible. At the Kansas Station soy bean meal proved equal to cottonseed meal in feeding value and much superior to linseed meal. This meal may well be fed with a larger quantity of corn or Kafir corn. At Woburn horse bean meal produced rapid gains in steers.

Cottonseed constitutes the most important ration for steers in the Southern States. Pound for pound it is superior to all other grain feeds in effectiveness in beef production. It may be fed raw, boiled, roasted or ground. It may be the only concentrated feed in a ration or may be fed in conjunction with corn, Kafir corn or other less highly nitrogenous grains. Neither cottonseed nor cottonseed meal is a safe feed if allowed to become rancid or dark colored. The meal should be perfectly fresh and of a yellow color. Cottonseed may be used as a complete ration for steers, the meal constituting the concentrated feed and the hulls serving as coarse fodder. There is also a "cottonseed feed" on the market supposed to contain 4 parts hulls and 1 part meal.

At the North Carolina Station good gains were made on an exclusive diet of cottonseed meal and hulls for a period of 81 days. The meal and hulls were fed in the proportion of 1 to 4. They may be fed for different purposes in proportions ranging from 1 to 1½ to 1 to 7. The ratio 1 to 1½ is well suited to rapid fattening. The hulls alone are not sufficient for maintenance, except perhaps those from green seed.

At the Texas Station cottonseed meal and hulls proved equal or superior to any other ration. Roasted or boiled cottonseed was found more palatable and less laxative than raw seed, but the cheapest gains were made on the raw seed. The best ration of meal and hulls for cheapness was 1 to 5 or 6, for rapid gains 1 to 3. Cottonseed did not produce any striking effect on the quality of the beef, but made a harder tallow than corn.

At the Arkansas Station cottonseed proved to be the cheapest and best grain for cattle. The whole seed was equal to the meal and hulls for a period of 60 days, but the extra quantity of oil in the whole seed caused loss of appetite in longer periods of feeding. The hulls should be fresh and free from seed; otherwise they may cause scouring. Hay may be fed if the animals scour. A ration containing 8 pounds cottonseed meal and 25 pounds hulls gives results equal to corn feeding.

In Mississippi 1 pound cottonseed meal proved equal to 1.66 pounds cottonseed or 1.9 pounds corn, and 1 pound of gain was produced by 2.4 pounds cottonseed meal. Cottonseed meal was fed in rations of 5½ pounds per day without harm, but 7½ pounds was too heavy a ration. The Oklahoma Station found cottonseed less satisfactory when fed alone than when combined with other grains. It rarely affects the health of steers except when fed to excess for long periods of hot weather. Eight pounds is considered a maximum feed and 4 to 6 pounds gave better results. Cattle may then lose appetite, but are not seriously affected. In the Northern States cottonseed is very effective when fed with some other grain, say corn, in the ratio of 1 to 4. In Tennessee cottonseed meal gave best results when mixed with corn meal in ration of 1 to 1¼.

Kafir Corn, although slightly inferior in feeding value to corn, may be substituted for the latter in a ration for steers. At the Kansas Station its feeding value proved to be somewhat lower than that of corn, and its fat was less digestible. Both red and white Kafir corn were found to be almost equal to corn in long fattening periods for steers. Corn meal was better digested than Kafir corn meal, 5½ per cent of the corn meal, 12 per cent of the red and 14 per cent of the white Kafir corn meal being found in the manure. Red Kafir corn proved somewhat superior to the white variety.

At the Oklahoma Station 10 per cent more Kafir corn meal than corn meal was required for a given gain. Kafir corn was found to be more digestible when soaked, and enough more effective when ground to pay for grinding.

Linseed Meal is fed to steers and other farm animals for its beneficial action on the general health, as well as for its nutritive qualities. It should be fed in small quantities as a part of the grain ration. In Iowa it was found quite inferior to corn meal for steers at pasture, and proved inferior to gluten meal in Ohio. At the Kansas Station an exclusive diet of linseed oil cake did not produce as good results as corn meal or a balanced ration. In Canada linseed meal added to a ration of grain and silage gave excellent results. Linseed cake was found a more profitable feed in England than cottonseed meal or dried brewers' grains. In Scotland it gave greater but more costly gains than cottonseed meal and oats.

Oats have not given very favorable results in fattening experiments with steers. Practical feeders, however, secure good profits from them when fed with other grains. In recent years oats have been fed to steers less extensively than barley and wheat. In Texas oats proved equal to corn chops for fattening steers, while in Wyoming chopped oats were fed at a loss, and in Canada oats in the sheaf had a smaller feeding value than wild rye grass. An experiment with oatmeal in Canada showed it to be far inferior to wheat.

Peas whole or ground are extensively fed in Canada and the Northern States. In one test at Toronto pea meal was found slightly inferior to corn meal, while in a later trial it gave greater but more costly gains. Peas and oats as a grain ration proved far inferior to wheat or oatmeal. Pea meal constitutes a portion of the mixed meal which is almost universally used in feeding steers in Canada. The large cattle feeding companies report good results from peas in fattening steers.

Wheat should not constitute the whole or even a large part of the grain ration for steers, except when the market price is low. In Minnesota it was found that wheat could be fed with profit and advantage to fattening steers when the market price was not higher than 47½ cents per bushel. In Colorado wheat with or without sugar beets produced good gains in steers. The shrinkage on shipping was greater than with corn, but less than with barley. Ground wheat proved superior to ground barley. At Toronto wheat bran was found more valuable for feeding purposes than whole wheat or wheat flour, and the new process bran gave the best results. In Maryland the new and old process wheat bran proved to be of equal value. In Oregon and Pennsylvania wheat alone was less effective than when mixed with corn or some other grain. Steers did better than pigs on wheat in the sheaf in Oregon, but the gains were costly and the meat did not mature so well as in steers which were fed ground wheat. In Wyoming cracked wheat was fed to steers at a loss. Frozen wheat has as high a feeding value as uninjured wheat and may be fed to steers with good profit. In Canada the use of frozen wheat and silage resulted in good gains and an excellent quality of beef. In England it was found that wheat could profitably be used to replace linseed meal in fattening steers. Chopped wheat with corn silage and hay gave good results in Idaho. In Nebraska, wheat showed a feeding value 5 per cent greater than corn. Hogs following steers fed on wheat made profitable gains.

At the Toronto Station the following results were obtained in a comparison of corn, peas and oats for steers. Besides grain the steers received roots, silage and hay:

Grains	Daily gain p. head	Cost p. lb. of gain	Cost p. st'r Oct. 1 to June 1
Corn	1.91 lbs	4.8 cts	$20.75
Peas	1.83 "	5.2 "	22.50
Oats	1.60 "	5.8 "	25.10

The best grain feeds for beef production in the corn belt are corn, Kafir corn and linseed meal; in the Northern and Western States corn, peas, barley, wheat and linseed meal, and in the South cottonseed, corn, Kafir corn and soy bean.

The average amount in pounds of different grains required for 100 pounds of gain in steers is shown in the following table, which is prepared from more than 100 experiments involving over 750 animals:

Barley	Corn	Kafir corn	Oats	Peas	Wheat	Mixed grain
914	1,028	1,058	1,032	911	1,090	871

In the majority of feeding experiments a-mixture of grains has been found more effective than any one of the grains in the mixture, and this fact also appears in the table of averages just given.

Coarse Fodders for Steers—A portion of the ration for steers must always consist of forage plants or roots. This part of the ration may be given as pasture, by soiling or by feeding hay, silage or roots in stalls or yards. The results obtained from experiments in pasturing steers are not very uniform. In Iowa steers often lost weight when turned on pasture, even when grain was fed. The loss was apparently due in part to exposure to heat and annoyances from flies. In Oklahoma steers on bluegrass pasture made very small and unsatisfactory gains for a period of 105 days. At the Ohio Station, when nearly finished steers were turned on pasture without change in their grain ration, they were checked in their growth or actually lost in weight. The same experience was had in Canada. In Minnesota sorghum, oat or rape pasture supported steers longer than field peas or corn, which latter do not sprout again after being eaten off. In Montana, alsike clover made excellent pasture.

The results obtained at several experiment stations indicate that it does not pay to feed grain to steers at pasture. This practice, however, is followed by many practical feeders with excellent results. Much depends upon the time of year and condition of the pasture. Steers ordinarily gain rapidly on good pasture. Under no circumstances should a sudden change be made after the steers are finished, from stalls to pasture or vice versa. A check or loss in weight is almost sure to follow. In Nebraska, grain feeding was profitable when steers were marketed in the fall but not when they were held till spring.

Soiling is a practice which is most largely followed by dairymen. It has not been tested to any great extent in fattening steers. In Massachusetts steers made much more rapid gains on soiling than on pasture. By the former method they ate more feed and the profits were about the same. Soiling with rye, clover and corn was found equal to pasture in Pennsylvania. In Utah pasturing, soiling and feeding hay seemed to be equally effective.

Roots are perhaps most valuable during the first part of the fattening period. From 40 to 50 pounds per day may be fed at first and the amount should be gradually diminished. In England it was found that more than 30 pounds of roots per day was apt to cause scouring. In Utah roots showed no advantage over ordinary air dried fodders. Steers fed on roots had larger vital organs, less fat and a smaller percentage of dressed weight than those which received dry fodder. Roots were, therefore, considered unprofitable as feed for steers. Silage is a more economical feed for steers than roots. Results secured in feeding experiments with the various kinds of roots are noted beyond under *Roots for Steers.*

The use and value of the coarse fodders most commonly fed to steers may be briefly discussed at this point, alphabetically.

Alfalfa Hay, throughout the regions where it is extensively grown, is one of the most important hays for cattle. At the Colorado Station 1 pound of alfalfa hay was found equal to 2.69 pounds corn silage. It proved equal to corn fodder pound for pound. The addition of grain to an alfalfa ration greatly increased the gains, but did not lessen the amount of hay eaten. In feeding steers a greater profit was derived from alfalfa than from corn fodder or silage. In Arizona 18 pounds of alfalfa hay and 2.6 pounds wheat were required for 1 pound of gain. It proved better than sorghum, but when fed with corn fodder, Kafir corn fodder or sorghum greater gains were made than when alfalfa was fed alone. In Utah alfalfa silage was inferior to corn silage, but the hay was superior to timothy or wild hay. In Nevada from 15 to 21½ pounds of alfalfa hay were required for 1 pound of gain in 2-year-old steers. With full feeds of alfalfa only a small amount of grain is required to make rapid gains.

At the Utah Station it was found that alfalfa cut just before blooming made better gains in steers than when cut in full bloom or 1 week after full bloom. The early cut of both the first and second crop proved to be superior. To secure the best feeding value it should therefore be cut between medium bloom and first full flower. The digestibility remains the same from the period of bud to that of full flower. Pound for pound the third crop was found to have the highest feeding value, followed by the first and second crops. The leaves proved to be 2 or 3 times as nutritious as the stems.

Buffalo-Grass Hay may well be fed to fattening steers wherever it is grown to such an extent as to make its harvesting economical. In Kansas it was found to be better than prairie hay and far superior to timothy.

Chess is often fed to steers, but there is very little experimental evidence concerning its value. In Oregon it proved slightly inferior to clover hay, but was valuable in a maintenance ration for wintering cattle.

Clover in the Central and Eastern States occupies the position in rations for steers which is filled by alfalfa in the West. In Tennessee the first crop had a greater feeding value and was better relished than the second crop, which caused salivation. In Mississippi greater and cheaper gains were made on clover hay than on shredded cornstalks, cowpea hay or crabgrass. In Indiana steers made better gains on chopped than on whole clover hay.

Corn throughout a large portion of the country furnishes the chief coarse fodder for steers. It may be fed in the form of corn stover, corn fodder, pulled fodder, shredded cornstalks, corn shives or the "new corn product" silage or as a soiling crop. As a rule corn can be most economically harvested and fed in the form of silage.

In Colorado 1 pound corn fodder was found equal to 2.4 pounds corn silage. In Iowa corn fodder proved superior to timothy hay, corn silage or sorghum silage. At the Illinois Station the digestibility of corn fodder and corn silage for steers was found to be the same. The fodder gave slightly larger gains in yearling heifers than silage. The heifers which were fed silage ate more and required more feed for a given gain. In Arizona the fodder was equal to alfalfa. Silage was superior to carrots and mangel-wurzels in Idaho. At the Maryland Station corn fodder gave best results when shredded, moistened and mixed with the grain ration. It was then more digestible, better relished and eaten more completely. The fodder showed twice the feeding value of cottonseed hulls. The corn shives or "new corn product" proved superior to shredded corn fodder, corn blades or timothy hay. It keeps well, is greatly relished and is convenient to feed. Cattle chew the cud after feeding on it as if fed on corn fodder or hay.

In Mississippi shredded cornstalks were found to require silage mixed with them to make them palatable. They were inferior to cowpea hay, crabgrass or clover hay, but their cheapness more than counterbalanced their inferior feeding value. Air dried corn fodder was more economically stored and handled than silage and was nearly equal to silage in feeding value.

In Massachusetts silage with bran and gluten meal gave the best and cheapest gains of the several rations which were tried. In North Carolina silage with cottonseed meal gave rapid gains. Corn silage fed in rations of 44 pounds for 11 days, followed by soy bean silage in rations of 44.8 pounds for 46 days produced moderate gains without grain. Silage was found more palatable than fodder at the Ohio Station. In Texas silage proved superior to dry fodder in feeding value. In Utah the fodder was found to be more effective than silage. In Virginia much cheaper gains were obtained from silage than from hay. In Wisconsin silage with a heavy grain ration was exceedingly effective, 35½ pounds of silage making 1 pound of gain. The silage from 1 acre made 700 pounds of beef. In Canada silage was found better than hay and turnips.

Cowpea Hay has been found an exceedingly valuable fodder for steers in the Southern States. In Arkansas it is considered the cheapest and best hay for cattle. Cowpea hay was found more digestible than clover hay in Illinois. In Tennessee 2 to 3 pounds cowpea hay proved equal to 1 pound of cottonseed meal. Together with grain it may be fed in rations of 20 pounds per day. In Tennessee the hay made a good substitute for cottonseed meal when fed at the rate of 2 or 3 pounds for each pound of the latter.

Kafir Corn stover in Oklahoma proved somewhat inferior to alfalfa hay but equal to corn stover. Kafir corn fodder was found to be inferior to corn fodder. In Kansas Kafir corn stover proved superior to corn stover.

Rye Grass is cut for hay in various parts of the country. In Canada it was found superior to oats in the sheaf for fattening steers.

Silage is here used to include certain kinds of mixed silage. In Maryland a silage containing corn, sorghum and soy bean when fed alone in rations of 40 pounds proved more than a maintenance ration for heifers in winter. In Canada the cost of gain on corn silage was 27 per cent greater than on Robertson's mixture. (See under *Sunflower*.)

Sorghum proved equal to alfalfa for steers in Arizona. In Iowa sorghum silage was as effective as corn silage, but was not so well relished. In New Mexico all of the non-saccharine sorghums were readily eaten by cattle and were usually preferred to alfalfa hay. Sorghum as a soiling crop produced rapid gains in Tennessee. In Texas it was found that steers shrunk less on shipping when fed on sorghum and cottonseed meal than when fed on meal and hulls alone.

SOY BEAN furnishes an excellent coarse fodder for steers. It is mostly fed in the form of silage. In Illinois the silage proved as digestible as clover hay.

STRAW of various sorts may profitably be fed with leguminous forage plants, other hays and grain. Steers usually eat straw more freely if given the liberty of a yard. Oats furnish the best straw. In Canada cheaper gains were made on a ration containing wheat straw than where hay was used. Oat straw mixed with silage in the proportion of 1 to 3 makes a good roughage for steers.

TIMOTHY at the Iowa Station proved inferior to corn fodder, but better than sorghum silage. For the maintenance of young steers about 19 pounds daily are required for each 1000 pounds of live weight. There is no difference in the feeding value of early and late cut timothy hay. The dry matter in timothy hay and corn silage was found to be of equal value at the Maine Station. In Utah timothy proved equally digestible green and as hay. It was found inferior to "wild hay." In Illinois, timothy proved inferior to clover and tended to the production of intestinal fat.

VETCH HAY, from experiments made at the Oregon Station, would appear to be about equal to clover hay for steers.

Roots for Steers—In feeding steers all roots should be sliced or pulped. They may be profitably fed to steers wherever they can be produced cheaply. Brief notes on a few roots follow:

CARROTS produced smaller gains in steers than dry fodders in Utah.

CASSAVA has been fed to steers in experiments at the Florida Station. It is a starchy feed and should be fed in combination with cottonseed meal, cowpeas or velvet beans. When fed in such rations it produced beef at a cost of 1 cent per pound. It gave greater gains and a larger percentage of dressed weight than cottonseed meal or corn meal. The profit from feeding cassava was greater than from corn, but less than from cottonseed.

POTATOES are often fed to steers when the potato market is low, but very few experiments have been made to test their value. In Germany it was found that they could be fed to steers in rations of 60 pounds per day in combination with clover hay and linseed meal.

SUGAR BEETS were found to have a feeding value of $3 per ton in Colorado. In Wyoming when used in rations of 14 pounds per day with alfalfa hay they made profitable gains. Beet leaf silage did not show much feeding value in German experiments.

The residues from the manufacture of beet sugar are fed in enormous quantities to stock in Europe and this country. In France beet pulp has been fed to steers in rations of 115 to 126 pounds daily, together with alfalfa and linseed meal. The steers made good gains and the pulp was estimated to have a feeding value of $1 per ton. The beet sugar factories throughout the country are selling pulp to the farmers for 50 cents per ton or giving it to them for hauling away. Reports thus far received are favorable to its use.

Miscellaneous Feeds for Steers: CONDIMENTAL AND MEDICINAL FEEDS, according to careful investigations at the Connecticut, Massachusetts and New Hampshire Stations, are compounded of well-known feeding stuffs and common drugs and sold at a ridiculously high price as compared with their value. The price charged for these patented feeds is from 3 to 10 times their real value and the extravagant claims made for them are quite unfounded.

MOLASSES of different origin has been fed much more extensively in Europe than in this country. In Texas it did not improve a ration containing silage. In Kansas it was found to be of little value for fattening steers. In France it was found valuable for making inferior hay more palatable.

WATER—At the Pennsylvania Station it was found that animals which had a supply of water before them all the time had a better appetite and consumed their feed with more relish than steers which were watered but once per day. A self-watering device saved some work and appeared to effect economy in amount of grain for 1 pound of gain. In North Carolina 2½ pounds of water were drunk by steers for each pound of dry feed (cottonseed meal and hulls). It does not pay to warm the water for steers except in the very coldest weather. In moderate weather warming the water proved harmful at the Minnesota Station.

SALT—A supply of salt should always be accessible to steers, preferably in the form of large pieces of rock salt. It has been estimated that steers require about 1 ounce per day for each 1000 pounds of live weight. Range steers are sometimes salted at regular intervals and sometimes left to satisfy their appetites in this direction by eating alkali. The latter practice cannot be recommended except where the alkali contains a large percentage of salt.

Loss of Appetite—Loss of appetite is usually due to feeding too large rations, to feeding moldy, fermented or unclean grain or fodder, to feeding 1 ration too long without change or to feeding a too one-sided ration. Getting off feed is a serious matter in fattening steers, and one concerning which no detailed advice can be given. Each stock raiser must learn by experience how to recognize the cause of the trouble and how to remedy or prevent it.

Number of Meals per Day—No valuable evidence has been obtained from experiments to determine whether it is best to feed steers 2 or 3 times per day. It may be well to feed young calves 4 or 5 times a day. Yearlings probably do better on 3 than on 2 meals per day, while 2 meals are enough for older cattle. At the Utah Station steers made greater and cheaper gains on 2 than on 3 meals per day. In fact, good results are obtained when the grain ration is given at a single feed each day.

Rations for Steers—In the hands of different feeders satisfactory results may be obtained from rations differing greatly in nature and composition. All forcing rations must contain both grain and coarse fodder. The relative proportion of grain and coarse fodder, however, will vary according to the nature of each and according to other circumstances. A few suggestions from experiments in various States are presented in this connection.

In Kansas steers allowed to graze on cowpeas and standing corn fodder and receiving cottonseed made gains at a cost of 1.6 cents per pound. In Iowa a varied ration made cheaper gains than a simple one. In finishing steers better results were obtained from narrowing the ration in the last period than from widening it. Changing steers from dry feeds to pasture or vice versa caused a period of slow and expensive gains. The cost of gain on dry feed was greater than on pasture, being 1.65 cents on grass alone and 4 cents on grain and pasture.

In Iowa narrow rations gave greatest and wide rations cheapest gains. The same results were obtained in Kansas where in repeated tests corn meal gave more profitable returns than balanced rations. In Maryland greater gains, a higher price for the meat and more profit were obtained from a narrow ration. Wide rations gave greater gains than narrow ones in Maine. (For a discussion of "wide" and "narrow" rations, "balanced" rations, etc., see under *Feeding Farm Animals.*) This result is in agreement with those from experiments in New York and Tennessee, as well as in Germany and Scotland. At the Maine Station it was found that up to 15 months of age greater gains were obtained in cattle from a nitrogenous ration, while in older steers the wide ration gave the best results. The relative weight of the internal organs and parts of the body and the proportion of fat, lean and water was the same from both rations. In Michigan a better quality of meat was obtained from a nitrogenous ration than from corn meal alone, while exactly the opposite result was obtained in New York.

At Toronto light grain rations were found more economical than heavy ones, but more rapid gains were made on the latter. The most economical method for long periods was found to be 1-3 pound of grain for each 100 pounds of live weight at the start, this amount to be gradually increased so that the average for the whole period would be ½ pound per day for each 100 pounds of live weight. Similar results were obtained in Montana. At Ottawa it was found profitable to omit grain entirely, or nearly so, from the first part of the feeding period. In Utah with steers which were fed 4, 6 and 8 pounds of grain per day the rapidity of gain increased and the cost decreased with the increase in the amount of grain. At the Ohio Station a heavy grain ration proved more profitable than a light one. In Minnesota steers which received 25 pounds of silage and hay per day made cheapest gains when fed 8½ pounds of mixed meal daily. When fed more than 10½ pounds per day they failed to make correspondingly increased gains. In other words, they were eating more than they could digest. In Massachusetts it was found that the larger the amount of hay fed the greater the cost of gain.

In Minnesota steers weighing 1050 pounds ate 25 pounds of silage, 8 1-3 pounds of hay and 8.6 pounds of corn meal daily. Hundreds of rations have been published which are suitable for fattening steers, but detailed directions cannot be given in this matter. Each feeder will compound his rations from the feeding stuffs which he has or can get most conveniently and according to prevailing market prices. It is believed, however, that some valuable suggestions may be obtained from the data presented in the preceding paragraphs.

At the Utah and Illinois Stations the effect of leaving all coarse fodder out of the rations was tested. In Utah cattle which were fed for a long period on grain alone made gains on less grain than that required by pigs for the same gain, and drank comparatively little water. The vital organs were small. In Illinois calves prevented from getting coarse fodder up to 5 and 7 months of age became nervous and showed depraved appetites. These experiments, however, are of little practical value, since the farmer will not attempt anything of the sort.

Dressed Weight, etc.—While the percentage of dressed weight has been found to vary from 40 per cent to 70 per cent in extreme cases, the average for various pure breeds, grades and scrubs in experiments conducted at the various stations is about 63.5 per cent. The amount of loose tallow varies from 11 per cent to 33 per cent of the dressed weight, depending largely on the type of animal. The average shrinkage in weight from shipping steers on the railroad as computed from 50,000 animals is 43 pounds per head.

What the Experiments Show:

1. For the production of beef pure beef breeds or good grades should be selected.
2. It does not pay to let calves suck the cows or to feed them whole milk. Feed skimmilk with a little corn meal or linseed meal.
3. It pays to force early maturing breeds from the start and market them at the age of 12 to 16 months.
4. The younger the steers the less feed they require for a given gain and the more rapid gains they make.
5. Steers should be sold as soon as they are finished off. The last few pounds of gain are costly.
6. For steers over 2 years of age a moderately wide ration is more profitable than a narrow one. In other words, corn may constitute the chief grain for fattening.

Dehorning Cattle—The practice of dehorning cattle is generally recommended by the experiment stations. If properly done the operation is not cruel or very painful. Dehorned animals recover from the bad effects of the operation within a few days, and the danger of animals injuring one another, especially in transportation, or in the case of vicious animals, is greatly lessened.

Experiments have been tried in dehorning calves at an early age by means of various chemical preparations. Caustic potash, hydrochloric acid, sulphuric acid mixed with sulphur, sulphuric acid mixed with glue and carbolic acid, chlorid of zinc, chromic acid ointment and chromic acid solution have been used for this purpose. The best success attended the use of caustic potash. This substance should be applied as follows: After clipping the hair from the skin and moistening the developing horn with water to which soap or ammonia has been added, a stick of caustic potash is dipped in water until somewhat softened and then rubbed on the moistened surface of the horn. The operation should be repeated from 5 to 8 times until the horn becomes somewhat sensitive. The whole operation should require only a few minutes. A scab forms over the budding horn and drops off within a month or 6 weeks, leaving a smooth poll. The best results in the use of caustic potash are obtained when this substance is applied as soon as it is possible to locate the horn button on the calf's head. which can usually be done within 3 or 4 days after birth. Caustic potash is the chief constituent of patented chemical dehorning substances and is cheaper than the latter.

The operation of dehorning adult cattle should be performed in mild weather, neither during extreme cold nor during fly time. A number of dehorning clippers have been patented and are for sale. Adult animals should be dehorned by an instrument which removes the horn at a single stroke. The dehorning of adult animals produces a marked gentleness and docility in animals which were previously vicious.

Diseases—For an account of the medicines and of the doses mentioned under the diseases below see *Veterinary Medicines.*

TUBERCULOSIS (consumption, phthisis, pearl disease, tubercular pneumonia, tubercular garget, tubercular meningitis, etc.)—Although this disease is one of the oldest of which there is definite record in literature, it is only within the past hundred years that its development and distribution among cattle and other domestic animals have acquired great economic importance in agriculture. Few subjects connected with agriculture and public sanitation have occasioned more extensive or more bitter controversy than that of tuberculosis. Not only has the existence of the tubercle bacillus been called in question, but even the existence of the disease itself has been much ridiculed at times and considered as chiefly imaginary. On the other hand, the extent and dangers of the disease have been much exaggerated and distorted to an absurd degree by sensational writers on the subject.

The chief questions in the mind of the average practical person concerning tuberculosis may be stated as follows: Is the disease an independent and specific affection? Are there several distinct forms of tuberculosis; for example, one of cattle, one of man, and one of birds; or are all forms of tuberculosis which occur in various domesticated animals and man mere variations of one and the same disease, which may be transmitted from animals to man and from man to animals? To what extent is tuberculosis transmitted from man to animals, particularly cattle? Is the consumption of milk and meat of tuberculous animals dangerous? What is the practical value and reliability of the tuberculin test, and what method may be adopted on a large scale which will give promise of an ultimate control or eradication of the disease?

With regard to the first question, it must be stated that extensive and careful studies and experiments by a large number of trained investigators have demonstrated that tuberculosis is a contagious disease, due to the presence in the tissue of the tubercle bacillus, frequently called also the bacillus of Koch, from the name of its discoverer. Tuberculosis not only attacks a greater number of animals than any other disease, but is of the most economic importance of all the plagues to which man and the domestic animals are susceptible. The tubercle bacillus has been isolated from diseased tissue and studied in pure cultures. Inoculations with bacilli thus obtained in experimental animals, such as rabbits and guinea pigs, invariably produce the disease with the usual symptoms. The tubercle bacillus is always present in actively developing tubercles which occur in animals affected with tuberculosis.

In investigating the subject of tuberculosis, it is of great practical importance to determine the essential unity or plurality of the disease. If pulmonary tuberculosis or consumption in man is distinct from the tuberculosis of cattle, there is evidently no danger in using the milk and flesh of tuberculous animals for food. If, on the other hand, it is once demonstrated that the milk and flesh of tuberculous cattle may carry an infection of tuberculosis to man, the great danger of using these products without preliminary treatment is at once evident.

The preponderance of authority has for some years favored the proposition of the essential unity of this disease in man and animals. A few experimenters had suggested the possibility of the tuberculosis of man being different from that of cattle and other domestic animals, but it remained for Koch, the discoverer of the bacillus and one of the greatest authorities on this disease, to formulate a statement implying the existence of 2 distinct forms of tuberculosis, one being confined to man and the other to domestic mammals. Dr. Koch's statement was made at the British Congress on Tuberculosis in 1901 and created intense excitement on the subject, which has resulted in greatly increased activity of investigators along this line. Koch stated his belief that tuberculosis of cattle is rarely transmitted to man and that therefore no especial precautions are necessary in safeguarding the public against the use of tuberculous meat and milk, and an even more positive assertion was made of nontransmission of tuberculosis from man to cattle. This statement was based on numerous experiments made by Koch, in which it was found impossible to produce the disease in animals by feeding or inoculating them with the sputum of tuberculous patients.

The one great benefit of Dr. Koch's thesis is that attention has thereby been called to the necessity of more extended and more careful experiments in order to determine definitely on an experimental basis the essential unity or plurality of tuberculosis. The amount of literature and the number of experiments performed on subjects relating to tuberculosis have increased enormously since the publication of Koch's address, and definite results have been obtained which disprove Koch's assertions. In nearly all publications on the subject since the appearance of Koch's address the attempt has been made to uphold the proposition that tuberculosis of man and animals is one and the same disease and may be transmitted from man to animals or from animals to man. This position had been gradually assumed by nearly all writers on the subject and the protests against Koch's thesis signified in the first place simply a reaction against his antagonism to accepted opinions. The greatest harm which has been caused by the publication of Koch's belief comes from the increased resistance to the enforcement of sanitary measures regarding meat and milk of tuberculous animals. Sanitary officers are now confronted with the statement by dairymen and meat dealers that the greatest authority on the subject of tuberculosis has asserted that there is no danger from using the milk and meat of tuberculous animals and that therefore no precautions are necessary. Such a state of affairs is somewhat unfortunate in view of the fact that aside from all consideration of the possibility of transmitting tuberculosis to man through the products of diseased cattle, these products may be unsanitary and unfit for food on account of extensive chemical changes which have taken place in consequence of the existence of disease. It has been definitely proved by the United States Bureau of Animal Industry and by many other experimenters in this country and elsewhere that human tuberculosis may be transmitted to animals.

While it is manifestly out of the question that direct experiments should be carried on in transmitting tuberculosis from animals to man, there is circumstantial evidence that tuberculosis may be acquired by man through the use of milk and meat of tuberculous cattle. The evidence for this statement comes from the study of infantile tuberculosis in cases where the milk of tuberculous cows forms the food. Many such outbreaks in children have apparently been traced to their origin in tuberculous milk.

Extensive series of experiments have been carried out in feeding the sputum of tuberculous human patients to various domestic animals, for the purpose of determining whether the disease could be transmitted in that way. Such experiments have been attended with varying and somewhat contradictory results. There is considerable variation in the resisting power of different animals to the tubercle bacillus in the intestines, and such feeding experiments therefore do not always bring about an infection of the experimental animals. Inoculation with the sputum of tuberculous human patients or with pure cultures of tubercle bacilli obtained from such sources, have produced in about 25 per cent of cases the development in the various domesticated animals of tuberculosis in a generalized form. An extended series of experiments conducted at the Arkansas Experiment Station with regard to the relative susceptibility of different animals to tuberculosis of bovine and human origin, showed that bovine tubercle is more virulent than human tubercle for cattle, sheep, goats and rabbits, while horses, pigs, dogs and cats were found to be equally susceptible to both varieties. The difference in virulence of tubercle bacilli from different sources and in the susceptibility of animals to infection from different sources, cannot be interpreted as lending weight to Koch's theory that human and bovine tubercles are 2 distinct varieties. Furthermore, the fact that the disease develops in somewhat different ways in cattle and in man is interpreted as indicating certain differences in the anatomy and physiology of cattle and man, rather than differences in the tubercle bacilli as obtained from these different sources. Experiments have shown that the disease may be transmitted from one mammal to another, either by means of inoculation, or through eating infected food. Young pigs fed upon the milk of tuberculous cows develop tuberculosis in a certain percentage of cases. Dogs, cats and other carnivora may become infected with the disease by eating the meat of tuberculous animals.

With regard to the identity of the tuberculosis of mammals with the form of the disease which occurs in birds, much more doubt has been expressed and the results of experiments for determining the matter have been even less uniform. In many instances inoculation of domestic fowls with tubercle bacilli obtained from human sputum or from bovine tubercles, has resulted negatively. Experiments in feeding such material to poultry have usually failed to develop the disease. In interpreting the results of such experiments, however, it is always necessary to remember that different animals have a very unequal resisting power to tuberculosis. In some animals the resisting power of the intestines toward tuberculosis is very great, while the lungs and respiratory passages may be exceedingly susceptible to the disease. Negative results from inoculation experiments can never be regarded as determining the virulence of the material which is used, unless the results are supported by evidence obtained in other ways.

The presence of tuberculosis due to a bacillus which cannot be distinguished from that which causes the same disease in mammals is well known in various domesticated and wild birds. Tuberculosis of the intestines and liver in the common fowl are sometimes exceedingly prevalent, and the disease is especially common among incubator chickens when confined in badly ventilated brooders. The disease in common fowls assumes in general 2 rather distinct forms, one affecting the intestines and causing tubercles in their walls, as well as throughout the substance of the liver and spleen. The other form is principally confined to the skin, and attacks especially the head and legs, causing swellings of greater or less size and abscesses which do not heal. Tuberculosis is especially common in parrots and other caged birds.

While there may be reasonable doubt as to the identity of the tuberculosis of mammals and birds, the majority of recent investigators are inclined to the view that all the various forms of tubercles observed in man, mammals and birds are examples of one and the same disease, which show certain differences in symptoms or lesions due to differences in the anatomy and constitution of the affected animals. Among domestic animals the disease is most frequent in cattle. Pigs are also very susceptible, while the horse, sheep and goat seem to be especially resistant. All kinds of animals kept in zoological gardens are more or less susceptible to the disease, and among the carnivora it has been observed in lions, tigers, jaguars, leopards, etc.

Great difference of opinion prevails with regard to the extent to which tuberculosis among cattle is due to infection from tuberculous human attendants. It is practically impossible to obtain any direct evidence bearing on this controversy, but in general it may be stated that the proof of such transmission from man to cattle is not forthcoming. Among the domesticated animals the disease appears to be chiefly transmitted from one individual to another of the same species. This is evidently due in great measure to the more intimate association of individuals of the same species than among animals of different species. An exception to this general statement is found in the case of hogs, in which tuberculosis frequently results from eating the offal from tuberculous cattle in the neighborhood of slaughterhouses. Although it has frequently been suspected that outbreaks of tuberculosis among cattle were due to the presence of tuberculous attendants, no good evidence has been obtained to prove this point. It would appear, therefore, that tuberculosis among cattle may be combated with promise of ultimate success without especial reference to the prevalence of the disease among human beings.

Transmission of the disease from animals to man, through the consumption of meat and milk of tuberculous animals, is considered by many authors as being of frequent occurrence. Numerous bacteriological examinations have demonstrated the presence of virulent tubercle bacilli in the milk of tuberculous cattle and in affected meat. Experiments in injecting such material into rabbits and guinea pigs have shown that a fatal form of the disease may be produced in this way. Feeding experiments during which such material was mixed with the ordinary food have resulted in the development of tuberculosis in calves, pigs, dogs, cats, colts, guinea pigs, and other animals. The form of the disease which is observed in such cases is frequently found in children and adult persons who have consumed milk from tuberculous cows. In many of these latter cases the evidence is not conclusive on account of the existence of other possible methods of infection. The possibility, therefore, that milk and meat from tuberculous animals may contain tubercle bacilli in a virulent form cannot be denied, and it is commonly believed that tuberculosis may be acquired from the presence of the tubercle bacillus in food. Such milk and meat must be considered dangerous to calves and hogs, and the only practical question which remains to be discussed in this connection concerns the degree of danger and the methods by which such danger may be avoided.

It may be stated at the outset that the milk of tuberculous cows does not always contain tubercle bacilli, and therefore is not always dangerous. Such milk is especially dangerous and is always to be condemned when the udder is diseased. It is perhaps not desirable to underestimate the danger from using tuberculous milk, from the fact that frequent experiments have shown that the tubercle bacilli are not always present in such milk. The bacilli may be found in milk for a few days, and may then be absent for a considerable time without any apparent changes in the condition of the animal which would account for these facts. Extensive experiments in Europe and the United States have demonstrated that during the first stages of tuberculosis in cows the milk may be fed to calves, or calves may be allowed to suck the cows, without much danger of contracting tuberculosis. In cows, however, in which the disease has progressed sufficiently to be diagnosed by physical symptoms, such as the general condition of the cow, coughing or the presence of tubercular swellings, the milk is almost always dangerous, and the majority of calves fed upon such milk contract the disease. An important practical question arises, therefore, in this connection, and concerns the advisability of using the milk of tuberculous cows under any circumstances without a previous pasteurization. (See *Dairy Farming.*) Some authors consider all such milk dangerous and recommend that it should be thoroughly pasteurized before using; while others recommend as safe its use during the early stages of the disease. It must be conceded, however, that the exact time at which such milk becomes dangerous in the general progress of the disease cannot be determined with great accuracy.

Tuberculin Tests—It appears that during the earlier stages of tuberculosis in cattle such animals are not liable to spread infection. After the lungs have become affected to such an extent that a chronic cough is manifested, or after the udder has become infected, the animals become a constant source of danger to other cattle. It is easy to appreciate, therefore, the value of a practical method by which the disease may be diagnosed in its earliest stages before there is danger of its transmission to other animals. Such a method is found in the use of tuberculin, which is now almost universally employed in the detection of incipient cases of the disease. Tuberculin may be described as containing essentially the products of the tubercle bacillus, especially the poisonous substances or toxins which cause the elevation of temperature, which is an almost constant symptom of tuberculosis. Tuberculin does not contain living tubercle bacilli, and cannot therefore produce the disease in healthy animals. The effects of injections of this substance in healthy animals in moderate doses are so slight as to escape detection. In the case of tuberculous animals injections of tuberculin cause a greater or less elevation of temperature, usually exceeding 1½° or 2°. In many cases certain other manifestations are noted, such as swelling at the point of injection, trembling and uneasiness, which may persist for a number of hours. The ordinary method of making tuberculin tests may be described as follows: The temperature of the animals which are to be tested is taken at intervals of from 1 to 2 hours for a period of about 12 hours previous to the injection. The injection of tuberculin is given hypodermically in the shoulder or other convenient place, and after a period of from 8 to 10 hours temperature readings are taken for from 3 to 5 times at intervals of from 1 to 2 hours. At the temperature readings taken after injection tuberculous animals will show an elevation of temperature and occasionally the other symptoms just mentioned. Such animals are said to react to the tuberculin test. Healthy animals, on the other hand, do not show these symptoms and are thus readily separated.

As already indicated, the chief value of tuberculin is found in the fact that by its use cases of tuberculosis may be detected before the disease has progressed sufficiently to be recognized by other means. Such animals may therefore be immediately quarantined or destroyed, according to the different methods which have been adopted. Exceedingly numerous tests of tuberculin have demonstrated that for practical purposes the substance is very reliable. It is apparently not absolutely infallible, since in rare instances reactions have occurred in animals which upon subsequent slaughter did not reveal any evidence of the disease. Such post-mortem examination, however, must always be regarded as unsatisfactory, since various slight lesions may easily escape notice. In some cases, also, tuberculous cattle fail to react to the tuberculin test. This is especially true, however, of advanced cases of tuberculosis which could be readily diagnosed by physical symptoms. Extensive statistics from tuberculin tests show a failure to react or an improper reaction in about 1 out of a thousand cases.

It is contended by the opponents of an extended use of tuberculin that the substance produces injurious effects in healthy cattle. In some instances tuberculin has been charged with being the cause of abortion. The weight of evidence, however, shows that such effects, if ever produced by tuberculin, must be considered as very exceptional, and the opposition to its use based on the contention that healthy animals sometimes react must fall to the ground if such animals are not destroyed but are separated from the rest of the herd and kept under observation.

It has frequently been noted that animals may fail to react to a second or third test with tuberculin if it is repeated after a short interval, and, in general, repeated tests of tuberculin cannot be considered as giving such reliable information as the first test. Tuberculous animals seem to acquire a sort of immunity to tuberculin, so that the injection does not produce the ordinary effect. These phenomena have frequently been interpreted as indicating a curative effect of the tuberculin. This idea is interesting, in view of the fact that tuberculin was first introduced as a possible cure for tuberculosis in man. The results of experiments thus far conducted, however, do not indicate that it uniformly exercises any curative action. Its use, therefore, as a curative agent in cattle by way of repeated injections receives little encouragement.

In making tuberculin tests on cattle it should always be remembered that there are a number of conditions which may tend to prevent or obscure the temperature reaction. Experiments have shown that large drafts of cold water may lower the temperature to such an extent as to render certain a faulty diagnosis after the tuberculin test. It is desirable, therefore, that water be given in small quantities and at short intervals after a tuberculin inoculation in order to prevent the lowering of temperature. In Europe in a few instances the administration of drugs for the purpose of lowering the temperature and preventing the tuberculin reaction has been suspected. A careful survey of the conditions surrounding a herd, however, will usually prevent any such fraudulent interference with the tuberculin test.

Methods of Eradication — Rational methods of eradication of this disease must be based upon a thorough understanding of its nature, extent and means of transmission. The various methods of eradication which have been proposed may be conveniently classified into 2 categories. Some authors have contended that the tuberculin test should be applied to all cattle, and that all animals which react should be immediately slaughtered and used for food after thorough cooking, or destroyed, according to the condition of the disease. The second method involves likewise the application of the tuberculin test. It does not, however, include the destruction of the reacting animals, but such animals are to be immediately separated from healthy animals and kept in separate pastures and quarters as long as they are useful. According to this method, the milk of cows which have reacted to the tuberculin test, as long as the udder is not affected, may be used after thorough pasteurization. The animals may be kept for breeding purposes and their calves removed into separate quarters and fed upon the milk of healthy cows or that of their own mothers after pasteurization. This method has been worked out in great detail by Prof. Bang of Denmark, and is usually known by his name.

If reacting animals are of common breed and of no especial value for breeding purposes, it is perhaps desirable to destroy them at once. If, on the other hand, tuberculosis is found in a herd of valuable high-bred animals, it has been found by numerous observations and experiments that the offspring of such animals are not tuberculous at birth and do not acquire tuberculosis if removed to healthy quarters. Such animals may therefore be retained for breeding purposes for a number of years, and in the meantime valuable offspring are obtained from them, so that a considerable proportion of the loss to the owner is avoided without danger of further spreading the disease. The method in question is founded on the observed fact that tuberculosis in animals is not hereditary.

It is probable that the method of eradication of tuberculosis by the immediate destruction of all reacting animals, if undertaken in a wholesale manner by State governments or the general government, would meet with considerable opposition by stock owners, who would thereby be put to total loss of all reacting animals. The granting of indemnities for diseased animals is coupled with great practical difficulties, partly in the matter of determining the value of condemned animals, and partly from the enormous governmental outlay which would be involved. It seems probable, however, that an enlightened public sentiment on the possible dangers of bovine tuberculosis to human health, and on the great financial losses occasioned by its prevalence in cattle, will support the gradual and universal extension of Bang's method for the eradication of this disease.

Von Behring, Pearson and others have recently shown that cattle may be immunized against tuberculosis by vaccination with human tubercle virus. The principle involved is the same as in vaccination for smallpox. This method promises to be of immense value in the control of tuberculosis.

Symptoms of Disease—The symptoms of tuberculosis vary somewhat in different species of animals and, as already indicated, are not easily recognized in the early stages of the disease. In cattle the first noticeable symptom of a chronic case of the disease is a dry cough, which is especially pronounced after sudden exposure to cold or after vigorous exercise. The condition of the animal slowly deteriorates and there is a more or less marked loss of flesh, accompanied by an unhealthy, staring appearance of the coat. The disease affects nearly all of the organs and tissues of the body, but in individual cases is usually confined to 1 organ or a set of neighboring organs. In internal organs the disease is characterized by the development of tubercles of size varying from that of a millet seed to that of a hen's egg, or greater. The contents of these tubercles ultimately change into a cheesy or calcareous mass. Such tubercles may be found in the lungs, liver, spleen and intestinal walls. The internal and the external lymphatic glands may also be affected, and their diseased condition may be recognized by the great increase in size. A chronic cough, accompanied by loss of flesh and poor general condition, should render any cow suspicious, and an examination by a veterinary surgeon will determine whether tuberculosis is present or not. If a case of tuberculosis of known long standing is determined by such an examination, it is of course advisable to apply the tuberculin test to the whole herd for the purpose of ascertaining whether the disease has spread to other animals.

(Ark. Expt. Sta. Bul. 57; Conn. Storrs Expt. Sta. Rpt. 1899, p. 150; Ohio Expt. Sta. Bul. 108; Wis. Expt. Sta. Rpt. 1899, p. 194; U. S. Dept. Agr. Bureau of Animal Industry, Buls. 7, 28, 32, 33, 44 and 52; Pa. Dept. Agr. Rpt. 1899, pt. 1, p. 323; Rpt. 1901, pt. 1, p. 286.)

Anthrax—This is a virulent infectious disease due to the anthrax bacillus, and is frequently known by the name charbon and carbuncular disease. It is most common in cattle and sheep, but occurs also in horses, mules, goats, dogs and cats. The disease may be transmitted from animals to man. The symptoms of anthrax vary according as the disease begins in the skin, lungs or intestines. Anthrax sometimes occurs in the apoplectic form, in which the animal suddenly falls down and dies in convulsions. In the acute form the disease begins with a high fever and terminates usually with fatal results within 2 or 3 days, while in the lingering form the course of the disease may extend from 3 to 7 days and end fatally, or, in some cases, with recovery. Breathing is labored and the mucous lining of the nose and mouth shows a blue color. In the intestinal form the discharges may be covered with mucus and blood. Swellings appear as carbuncles, and when opened are found to contain a yellowish mass stained with blood. They appear in the skin, mouth, tongue or rectum. The bodies of animals which have died of anthrax bloat rapidly.

The disease is most prevalent in areas subject to inundation. Pools of stagnant water and streams polluted with waste material from tanneries may be sources of infection. Contagion may also be spread through the bodies of dead animals or by insects or carrion birds, which visit anthrax carcasses. The anthrax bacillus may gain entrance to the body through infected water or food or through wounds in the skin. In Delaware it has been found that there are 5 distinct centers of contagion included in a territory which is crossed by the tidal streams or creeks and subject to tidal overflow. Outbreaks of anthrax in this region were traced to infection from skins used in morocco factories.

Medical treatment as a rule is useless, except in cases which originate from external wounds. The main reliance in combating the disease is to be placed in preventive inoculation. Stables should be disinfected with chlorid of lime or other substance, and cattle should be removed from fields which are likely to be infected. All infectious material should be burned. Animals dead of anthrax should be carefully buried or preferably burned. The continued prevalence of the disease in some localities has been shown to depend directly upon the neglect to destroy carcasses of dead animals. Vaccination of susceptible animals for the purpose of preventing infection by anthrax has proved very successful, the vast majority of vaccinated animals failing to develop the disease after being exposed. The vaccine material used may be obtained from dealers in such substances. (Del. Expt. Sta. Buls. 32, 37; La. Expt. Sta. Bul. 60.)

ABORTION—By this term is meant the premature expulsion of the offspring. Abortion may be noncontagious or contagious. The predisposing causes of noncontagious abortion are general debility, fevers, acute diseases—especially of the ovaries and bladder—indigestion, bloating, ergot, smutted grains and grasses, or muscular strain.

Contagious abortion occurs most frequently in cows, but is also common in horses, sheep and goats. It spreads from animal to animal or from herd to herd by means of contagion. The importation of an aborting cow into a herd may lead to an outbreak of the disease. It may also be transmitted by bulls which have served infected cows. The disease may be acquired by rubbing the genital organs against infected stalls or fences.

The symptoms of infection by this disease are not characteristic and often escape notice. A general disinfection is required in case of an outbreak. Cows before service may be given a vaginal injection of creolin in a 2 per cent solution or other antiseptic substance. Similar treatment should be given in all cases of actual abortion. The fetus and afterbirth should be burned and the stable thoroughly disinfected. The vulva and hind parts of aborting cows should be washed with an antiseptic solution. The bull should also be disinfected before service. Aborting cows may be separated from the rest of the herd in order to prevent further spread of the disease.

TEXAS FEVER, also called Southern cattle fever, Southern cattle plague, splenetic fever, acclimatization fever, etc., is a specific infectious malady, due to a parasite of the red blood corpuscles known as *Pyrosoma bigeminum.* The blood parasite is transmitted from one animal to another by the cattle tick, in which the parasite may live an indefinite time. Ticks which are attached or have been previously attached to cattle which are suffering from Texas fever, or which have recovered from Texas fever, contain the blood parasite. The immediate cause of the disease is the attack of this parasite upon the blood corpuscles, causing a disintegration of the latter and a great increase in the amount of waste material which must be removed from the body. Additional work is thereby put upon the liver and kidneys, with the result that one of the symptoms of the disease is a decided rise in temperature to 104° or 107° F. The symptoms of Texas fever vary according to the severity of the tick infestation, constitution of the animal and climatic and other conditions. A rise of temperature is first noted, and the animal becomes depressed and loses its appetite. Constipation is frequently observed and diarrhea often sets in before death. The red blood corpuscles are broken up by the blood parasites, and the red coloring matter becomes dissolved in the blood, with the result that it is secreted by the kidneys to such an extent as to give the disease the name of red water. The liver, kidneys and spleen become swollen, breathing is rapid and the pulse is accelerated and weak. The period of incubation varies from 2 to 5 weeks, but the first symptoms usually appear within from 9 to 14 days. The disease is usually fatal, and medical treatment is for the most part unsuccessful.* Cold weather prevents the spread of the disease to some extent, while warm weather is favorable to its development.

A quarantine line for Texas fever has been extended across the country by the Bureau of Animal Industry. The infected area includes in general the coast region from Virginia to Mexico, and extends northward with a variable outline. Cattle from below the quarantine line are usually infected with ticks containing the blood parasite. Such animals are immune in consequence of having recovered from attacks of the disease. The recovery of the majority of Southern cattle from Texas fever is probably due to the fact that their infestation by ticks takes place in a slow and gradual manner at an early age, and that a mild form of the disease thus produced brings about a complete immunity to the disease. Northern cattle when exposed to tick infestation contract an acute form of the disease and only a small percentage recover. Northern cattle may become infested with ticks either by exposure to the Southern cattle which have been shipped to the North, or by being shipped south of the quarantine line.

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*Recent experiments in Germany have shown good results from hypodermic injections of hemoglobin.

Treatment—Three different methods for producing artificial immunity to the disease have been tested, viz., by sterile blood serum of immune Southern cattle, by gradual tick infestation and by injections of blood of immune Southern cattle. Recent experiments indicate clearly. that immunity can be brought about only by the production of a mild form of the disease in the animals which are to be immunized, and while this may be accomplished by any of the 3 methods just mentioned, the best success has been obtained by application of the third method. From 1 to 2½ cc. of defibrinated blood given hypodermically produces an inoculation fever which begins usually 8 or 9 days after inoculation and persists for 7 or 8 days. The average daily temperature during the primary fever period is about 104.5°. Usually a secondary fever period occurs about 25 or 30 days after inoculation and persists for 1 week. The secondary fever is not as severe as the first, and when subsequent recurrences are noticed they are usually of a still milder form. The percentage of red blood corpuscles gradually decreases during the fever attacks, and their destruction reaches the maximum at about the 15th day after inoculation. Bloating, disturbances of the appetite, trembling, are sometimes noticed during the progress of the inoculation fever. In some cases the lowest percentage of red blood corpuscles is noted during the secondary fever period.

Young animals withstand the inoculation fever better than older ones. The most suitable age for inoculation is probably from 8 to 12 months. The blood to be used for inoculation purposes should come from animals which are thoroughly immune to the disease and should be perfectly fresh. Especial attention should be given to the diet and care of animals during the period of inoculation fever. The process of immunization is gradual, and animals should not be considered entirely immune after the treatment just described until they have been kept in the South for 1 year and have been subjected to tick infestation. It has been shown that gorged ticks from recently immunized animals can be used as receptacles for containing virulent blood and can be shipped to long distances without the blood undergoing any changes. Such ticks may then be crushed and the blood

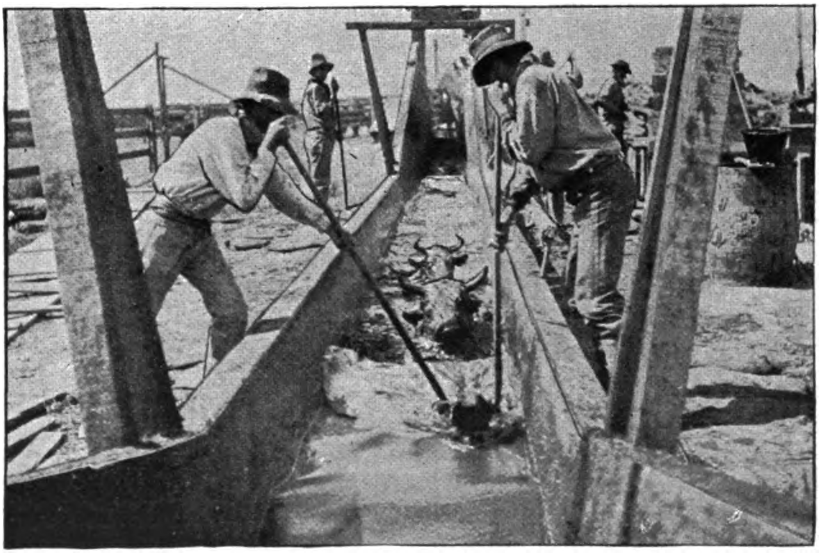

Fig. 346—DIPPING VAT FOR CATTLE
(Breeder's Gazette)

taken for inoculation purposes. This method is convenient in some localities where difficulties may be experienced in obtaining an immune Southern animal from which to secure blood.

The cattle ticks are capable of living a long time without food. This period is less in summer than in winter. Ticks endure a temperature of 16° F. Below this point death takes place. It is claimed by some authorities that pastures may be disinfected by removing all cattle from them for a period of 1 year. This must, however, remain rather doubtful.

Ticks may be removed from animals by the use of kerosene oil applied with a sponge or rag, or by plunging the animals into a vat containing water upon the surface of which a layer of oil is maintained. Dipping vats for the purpose of destroying ticks on cattle have been used in several localities. Such vats are constructed to hold enough water with a layer of oil on the surface for the complete immersion of cattle when plunged in from a chute, as seen in Fig. 346. At the opposite side of the vat, inclined somewhat, with cleats nailed upon them, are planks arranged for the exit of the animal. It is not necessary that the vats should be filled with a solid body of oil; a layer of oil of 40 or 42 inches depth is sufficient. Animals are completely immersed, swim through the oil, and, after emerging from the vat, are allowed to stand on a dripping platform from 5 to 10 minutes. Certain injurious effects are nearly always produced by dipping. Within a few hours after dipping the cattle show an irritation of the eyes and other parts of the head, and in some cases an elevation of the temperature.

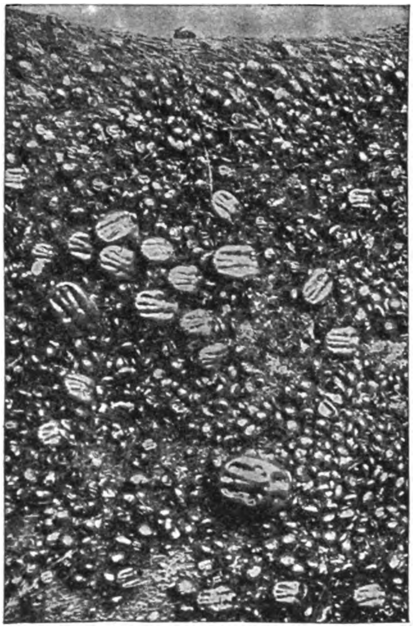

Fig. 347—CATTLE TICKS ON THE SKIN (Bureau Animal Industry)

The cattle tick (*Boophilus bovis*) is a reddish, flattened species, with an oval body contracted just behind the middle, with 2 longitudinal depressions above this contraction and 3 below it. When gorged with blood the ticks are nearly as deep as wide, as seen in Fig. 347. Experiments indicate that other species of ticks are not concerned in the transmission of Texas fever. The cattle tick appears on cattle about the first of June. When mature they drop to the ground, seek a sheltered spot and deposit their eggs. The eggs hatch in about 25 days, when the young ticks distribute themselves in the grass and weeds, and from these locations find opportunity of attaching themselves to cattle. In the immature condition ticks are capable of living all summer without blood. Ticks seem to be unable to exist in the Northern States. South of the quarantine line they pass the winter in the egg or adult stage, or both. Aside from the possibility of the infection of Texas fever through the agency of ticks, their presence in large numbers on animals causes a loss of blood, which may be a severe drain upon the constitution of the animals. In some localities they become so numerous on cattle that dipping or other treatment is necessary at intervals of greater or less length. Beside the dipping method tobacco infusion, kerosene emulsion and other remedies have been recommended for the destruction of ticks. A rational rotation of crops upon infested areas will exterminate the cattle tick in some instances, but this method cannot be relied upon completely, since ticks may escape into fence corners and waste places which cannot be subjected to cultivation. (U. S. Dept. Agr., Bureau of Animal Industry, Bul. 1, Rpt. 1899, p. 33; Kan. Expt. Sta. Bul. 69; La. Expt. Sta. Bul. 57; Mo. Expt. Sta. Bul. 48; Okla. Expt. Sta. Bul. 39; Va. Expt. Sta. Bul. 104.)

Blackleg, also called black quarter or symptomatic anthrax, is an infectious disease characterized by the development of tumors in the muscles of various parts of the body, and is due to the presence of a bacillus. The disease is mostly confined to cattle, but cases have been known in sheep, goats, horses and dogs. Man is immune to blackleg. Cattle between 6 months and 4 years of age are most susceptible, sucking calves and old animals being less subject to the disease. Blackleg usually runs its course rapidly and is ordinarily fatal.

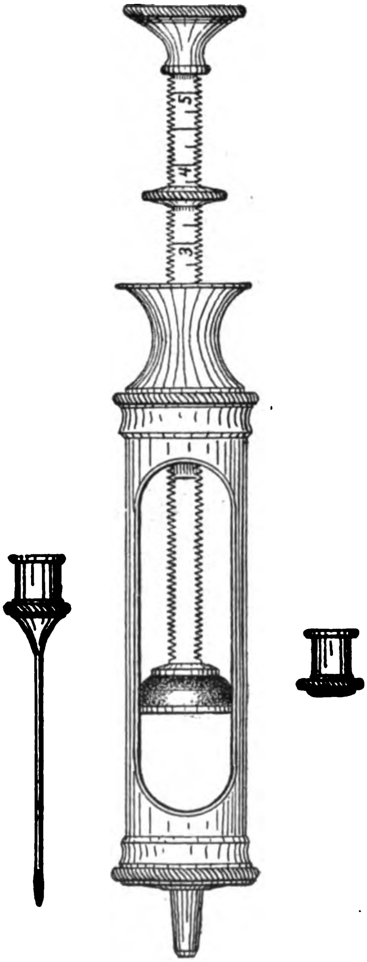

Fig. 348—HYPODERMIC SYRINGE FOR INJECTING BLACKLEG VACCINE
(Bureau Animal Industry)

The dry spores of the blackleg bacillus may be carried in hay or other feed, and animals may be infected by eating such material. The blackleg bacillus, however, usually gains entrance to the body through wounds in the skin, mouth, tongue or throat.

The symptoms of blackleg are loss of appetite, dullness, debility and high fever. These symptoms appear in from 1 to 3 days after infection has taken place. A lameness or stiffness of the legs is usually noticed, due to muscular swellings. Death occurs within 1½ days after the first appearance of the symptoms. Blackleg is distinguished from anthrax by the development of characteristic tumors, which emit a crackling sound when stroked. After death from blackleg, blood and yellowish material filled with gas bubbles may be found in these tumors. In anthrax the spleen is much enlarged and the blood does not clot freely, while in blackleg the spleen is not affected and the blood clots readily. The carbuncles and swellings of anthrax differ from those of blackleg in not containing gas and in causing death less rapidly.

Treatment by drugs is generally unsuccessful and is not to be recommended. Good results have attended the use of vaccine in preventing the development of blackleg. Vaccine for this purpose has been produced and distributed by the Bureau of Animal Industry, and reports from different parts of the country indicate that it is a practical and efficient means of controlling the disease. A syringe for injecting blackleg vaccine is shown in Fig. 348. The vaccine may be obtained from the Bureau of Animal Industry, State veterinarians and private dealers. (U. S. Dept. Agr., Bureau of Animal Industry, Rpt. 1898, p. 27.)

Actinomycosis, also called big jaw, lumpy jaw and wooden tongue, is an infectious disease due to the action of a parasitic organism known as the ray fungus. . This fungus causes local affections in the form of tumors of the bone and other tissues. The disease is common in cattle, but affects also man, horse, pig, sheep and deer. The parasitic organism is found in all tumors and abscesses of the disease. Its presence may be detected with the naked eye or with a small hand lens, in the form of minute yellow spots in affected tissues. The most common location of the disease is in the bones of the upper and lower jaw (Fig. 349), the salivary glands at the angle of the jaw, and in the region of the throat. Tumors may also be found upon the tongue and the mouth. The disease is occasionally observed in the lungs and alimentary tract, and is perhaps sometimes mistaken for tuberculosis. The ray fungus finds entrance to the animals through wounds or abrasions of the skin or internal mucous membranes. A large proportion of the cases of actinomycosis develop tumors only in the jaw bone or other structures of the head, and it is probable that the ray fungus often becomes first established in wounds of the mouth or through decayed teeth. As the disease progresses the parasitic organism invades all parts of the body, producing tumors, some of which result in running sores, especially when the lymphatic glands of the skin are attacked.

The first treatment adopted in combating this disease was the removal of the tumors by means of the knife or with caustic applications. Subsequent experiments in Europe and in the United States demonstrated that actinomycosis may be successfully treated with iodid of potash. The proper dose of this substance is from 8 to 12 grams, according to the size of the animal. This dose may be given daily for from 5 to 6 days, when a mucous discharge from the nose and eyes will be noted. The treatment should then be interrupted for 2 or 3 days, at the end of which time another week's treatment may be given. Iodid of potash should be administered in solution in water in the form of a drench.

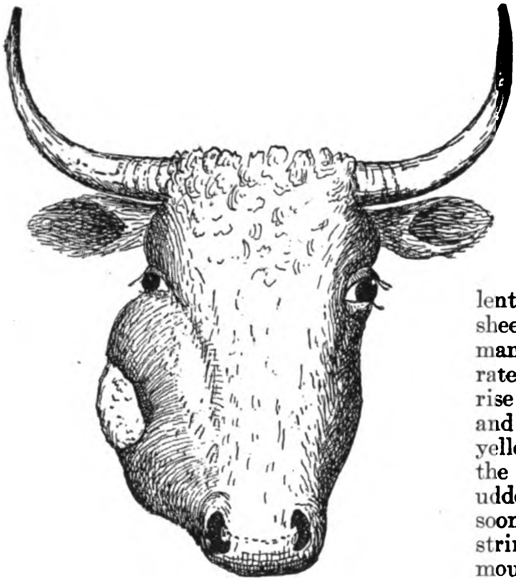

Fig. 349—ACTINOMYCOSIS OR BIG JAW (Bureau Animal Industry)

The organism which causes this disease is believed to be a degenerated form of a fungus which grows naturally upon feeding stuffs or grain, and it is thought that when the spores of the original fungus are taken into the digestive tract they gain entrance to the tissues and produce the disease. (U. S. Dept. Agr., Bureau of Animal Industry, Bul. 2; Spec. Rpt. on Diseases of Cattle, p. 409.)

Foot and Mouth Disease—This disease is common throughout Europe and other foreign countries. Strict quarantine measures, however, prevented its introduction into this country until 1903, when a quite serious outbreak occurred in New England, involving several States. The United States Bureau of Animal Industry, assisted by State authorities, at once began a campaign of quarantine and eradication, and carried it out with complete success. The method consisted in killing and burying or burning diseased animals, for which an indemnity was paid to the owners.

The disease is highly infectious, the virus being found in eruptions in the mouth and on the feet, in the milk and other products of diseased animals. It is most prevalent in cattle and swine, but goats, sheep, horses, dogs, cats, fowls and man are sometimes affected. The death rate is low. The chief symptoms are rise of temperature, loss of appetite and salivation, followed by eruption of yellowish blisters in the mouth and on the tongue and lips. The feet and udder may also be affected. The blisters soon burst and large quantities of stringy saliva are discharged from the mouth. Ordinary cases usually recover rapidly—within 10 to 20 days. The disease may be complicated with catarrh, pneumonia and loss of the hoofs, in which cases the usual outcome is death. The milk of cows affected with foot and mouth disease is very dangerous for children as well as for calves or swine.

A method of preventive vaccination has been devised for this disease, but the immunity produced is of very short duration. Baccelli claims to have had good results in treating the disease by intravenous injections of corrosive sublimate, but other investigators have failed to obtain such results. The best method of eradication consists in strict quarantine, destruction of diseased animals and thorough disinfection of premises where the disease has occurred. For further details see 19th Report Bureau of Animal Industry.

Milk Fever, also known as parturient apoplexy or parturient paresis, is a disease peculiar to the cow, and is frequent in cows of improved breeds, in a plethoric condition at the time of calving. The predisposing causes usually assigned are confinement in badly ventilated quarters, high temperature, electric disturbances and mature age. The disease does not appear at the first parturition, and rarely with the second. Calving is an essential condition to the development of milk fever. A few cases are recorded of its occurring some weeks after this period. Ordinarily the disease appears in from 1 to 3 days after calving. The actual cause of the disease is not understood, and the various theories which have been advanced to account for it are mutually contradictory. According to some authors the disease is due to an excessive milk secretion, while others maintain, apparently with equal justification, that the cessation of milk secretion brings about the disease. In the congestive form of milk fever there is a sudden dullness, drooping of the head and nervous movement of the hind legs and tail. The cow no longer notices her feed and calf. Weakness increases, until the cow lies down and is unable to rise. At this stage the temperature is elevated, the head, horns and ears being especially feverish. The cow usually lies upon the breast bone, with the neck bent and the head resting on the right flank. The head is frequently raised and dashed upon the ground, while at the same time the legs struggle convulsively. In the later stages the temperature usually falls below the normal. The bowels are constipated. In the torpid form of the disease there may be no especial heat about the head, but otherwise the symptoms are similar to those already described, with the exception that the disease progresses less rapidly. Until recently the treatment adopted for milk fever consisted in the use of purgatives (1 to 2 pounds of Epsom salts), ice bags on the head and doses of 20 to 30 drops of tincture of aconite every 3 or 4 hours. After the fever and constipation were overcome, stimulants such as nux vomica in ½ dram doses were given until the cow regained sufficient strength to stand. Within the past few years the Schmidt treatment has been used with good results. This consists in the injection of 10 grams iodid of potash into the udder as soon as possible after the symptoms of milk fever are noticed. In a large percentage of cases the animal recovers with 1 dose. Occasionally a second dose may be necessary after 24 hours. According to the Schmidt treatment the infusion of iodid of potash is given through the milk duct without injury to the tissues of the udder. Experiments have also shown that good results may be obtained by the hypodermic use of solutions of iodid of potash, and also by the use of injections of antiseptics into the udder, such as lysol. Quite recently good results have been obtained by distending the udder with warm water, oxygen or air. (U. S. Dept. Agr., Bureau of Animal Industry, Spec. Rpt. on Diseases of Cattle; Ark. Expt. Sta. Bul. 35; La. Expt. Sta. Bul. 10; N. J. Expt. Sta. Rpt. 1897, p. 241.)

Mammitis, also called garget, inflammation of the udder, or mastitis, is a disease of the udder common in cows which are heavily fed at the time of calving. It is especially frequent in heavy milkers. The udder becomes enlarged, hot and dense. A more or less pronounced congestion of the udder is almost always present at the time of calving, and this condition may be aggravated by standing in drafts or by neglecting to milk for a day or two. In such cases the milk may have a reddish tinge or may contain blood partly clotted. When withdrawn the milk may have a yellowish appearance, due to the separation of the casein in it. In the more acute cases a fever temperature may be established, the flow of milk is decreased and the cow gives evidence of pain in milking. If the condition is not relieved abscesses may form in the udder, and 1 or more quarters may cease entirely to secrete milk.

In treating this disease the milk should be drawn frequently and hot poultices applied to the udder. A soothing ointment may be rubbed on this organ. The following formula has been much used for this purpose: Eight ounces of vaseline, 3 ounces each of extract of belladonna, gum camphor and extract of henbane. If the udder becomes hard it may be rubbed with an ointment containing 1 dram each iodin and iodid of potash and 4 ounces of potash. During an attack of mammitis the diet should be light and a purgative of Epsom salts may be given to reduce the temperature.

In cases where mammitis is associated with evidence of constitutional disease in the animal, and where it persists for a long time with pus in the milk, tuberculosis of the udder is to be suspected. The disease is usually due to injuries of the mammary gland or retention of the milk. Sometimes, however, it is of an infectious nature, and in such cases great care should be exercised in preventing a spread of the disease through the milk which is removed from affected udders. In cases of infectious mammitis, injections into the udder may be given, 1-10 per cent solution of corrosive sublimate or other antiseptic substances being recommended. (U. S. Dept. Agr., Bureau of Animal Industry, Spec. Rpt. on Cattle Diseases; Kan. Expt. Sta. Bul. 49; La. Expt. Sta. Bul. 10.)

Cornstalk Disease, also called corn fodder disease, affects cattle and frequently horses and sheep. The cause of the disease is not definitely known. The symptoms are digestive disturbances, accompanied with delirium and unconsciousness. At first there may be evidence of weakness, which becomes more pronounced, until the hind parts are paralyzed. Death usually results 24 hours after the first symptoms are noticed. Several theories have been entertained with reference to the cause of this disease. It has been supposed by some to be due to corn smut or to the Burrill disease of corn. It has been suspected that a fatal poison may develop in the cornstalk and cause the death of the animals feeding upon it. Corn smut extracted with alcohol was given to guinea pigs without producing any bad effect. Chemical tests failed to detect any poisonous alkaloid in the smut. Growing corn inoculated with the Burrill corn disease and fed to cattle produced no poisonous effect. Pure cultures of the corn disease germs caused a slight diarrhea, but no serious symptoms. Experiments in feeding smutted corn to colts and old horses gave entirely negative results. It has been suggested that cornstalk disease is a combination of indigestion and the action of some poisonous substance in the cornstalks, perhaps saltpeter. An investigation at the Kansas Station, where a number of cattle died a few hours after eating cornstalks, revealed the presence of large quantities of nitrate of potash (saltpeter) in them. The nitrate of potash had crystallized into a white powder just inside the leaves at the joints of the stem, and also inside the stalks. Chemical analyses gave 18.8 per cent of the dry weight of the stalk as nitrate of potash. In order to determine the action of the nitrate of potash, a heifer weighing about 500 pounds was fed 65 grams of nitrate of potash, but was not seriously affected. In other cases death was produced within about 24 hours. The cornstalk disease needs further investigation before it can be stated with certainty whether the cause of the death of cattle from eating cornstalks is always the same. (U. S. Dept. Agr., Bureau of Animal Industry, Bul. 10; Neb. Expt. Sta. Buls. 7, 8, 9, 10, 23 and 52 and Rpt. for 1902; Kan. Expt. Sta. Bul. 49.)

Bloating, also called tympanites or hoven, is produced by the formation of gas in the first stomach. It may be caused by eating any kind of food which produces indigestion. Usually, however, the trouble is due to eating corn, alfalfa or clovers. According to some stock raisers, the danger from eating such plants is especially great when the dew is on, or immediately after a frost. Cattle gradually acquire an immunity to such danger, and after being pastured for some time on alfalfa or clover are not so apt to be badly affected. In the treatment of bloating large doses of soda dissolved in water may be administered with melted lard or other harmless oil. When the pressure upon the inside of the stomach has become so great that the animal cannot walk, it is necessary to resort to paunching. This operation consists in making an opening in the stomach, directly through the body wall, and may be accomplished by means of a thrust with a knife or by the use of a trochar and canula, which may be obtained from dealers in veterinary instruments. The point for making the incision is described as equally distant from the last rib, the hip bone and the side processes of the vertebral column upon the left side of the animal.

Other Diseases—Cattle are subject to various other diseases of the digestive organs, of the heart and blood vessels, the organs of respiration, the nervous system, urinary organs, generative organs, skin, feet, eyes, ears and other organs, most of which are not of serious character, and may be easily recognized and treated by the average stock raiser. The bare mention of all the diseases which have been recognized and described as affecting cattle would require considerable space, and reference to them is evidently impossible in this place.

Joint-Ill—Attention should be called to a disease in young calves, known as joint-ill. This occurs within the first few months after birth and is usually connected with disease of the navel. The symptoms are swelling of 1 or more joints, lameness and indifference to surroundings. A high fever and accelerated pulse are noticed. Treatment of this disease should be antiseptic and should begin with sanitation in the buildings and with treatment of the umbilical cord. The disease is probably acquired by infection through this structure, and anything which tends to prevent the umbilical cord from coming in contact with filth will also prevent the development of the disease.

Scouring in calves is a result of indigestion and may or may not be of serious nature. Occasionally the disease is contagious and occurs in an epizootic form. The condition of the mother, and especially the nature and composition of the milk, have considerable influence upon the development or prevention of this trouble in calves. When the disease is once established it frequently perpetuates itself by contagion and becomes a plague in the herd or whole district. The contagious form of scouring, often known as "white scours," is due to an infection which enters by the navel cord at birth. The navel cord should be washed with a solution of 1 part crude carbolic acid in 100 parts water. In the simpler form feeding rye bran is one of the best means of controlling it. (See also *Calves* under *Cattle.*)

Malignant Catarrh is an acute infectious disease of cattle, attacking primarily the respiratory and digestive organs. The cause has not been definitely determined, but it is generally believed to be due to micro-organisms. The disease most often attacks young and well-nourished animals in the spring of the year. The first symptoms are a chill, followed by high fever. There is a marked quivering of the muscles and dullness, passing into a stupefied condition. The secretion of milk is checked. Inflammation of the mucous membranes of the mouth and nose leads to discharges which are frequently watery, and later become thicker and occasionally streaked with blood. Constipation at the beginning of the disease is followed later by diarrhea. From 50 to 90 per cent of animals affected with this disease die. There is no specific treatment for the disease. The various symptoms may be combated as they arise by appropriate remedies. The proper preventive treatment consists in a removal of infected animals and a thorough cleaning and disinfection of stables.

Pleuro-Pneumonia — No cases of contagious pleuro-pneumonia of cattle have occurred in this country since 1892. The Bureau of Animal Industry has successfully eradicated the disease, and it is not necessary to describe it in this connection.

Ox Warble—Among the various insects which attack cattle mention may here be made of the ox warble, hornfly and buffalo gnat. The ox warble (*Hypoderma lineata*) is a black fly, thickly covered with yellowish hairs, and about ½ inch in length. The body is twice banded with yellow and white. From June to September the flies lay eggs on the back of cattle, and the grubs upon hatching bore into the skin of the animal and live there during the winter and spring. According to some observers, however, the grubs make their way into the gullet and later bore through the tissues, finally appearing under the skin. Upon reaching full size the grub emerges from the skin and falls to the ground. The chief injury from these insects is done to the hides and skin of the animals, and the loss is considerable. In preventing the attacks of this insect the backs of cattle may be treated with kerosene, train oil or fish oil. The grubs may be squeezed out and destroyed, or the opening may be smeared over with grease in which sulphur has been mixed to destroy the warbles.

Hornfly—The hornfly (*Haematobia serrata*) was introduced from Europe and has become quite generally distributed over the country. It is smaller than the housefly, but closely resembles the latter. The hornfly appears in swarms and is in the habit of collecting in great numbers upon the base of the horns. This habit has given them their name. They attack cattle, especially upon the flanks and shoulders, in places where they are not easily warded off. A mixture of 2 parts crude cottonseed oil or fish oil and 1 part pine tar may be applied to the flanks, back, fore quarters and horns, at milking time, in order to keep off the flies. Fresh applications should be made every week or 10 days. The swarms of flies upon cattle may be killed by spraying with kerosene emulsion. Good results have also been obtained by using crude kerosene oil 100 parts, carbolic acid 3 parts, applied with a brush. The eggs of hornflies are deposited in fresh manure, and maggots may be destroyed by covering the manure with lime.

Buffalo Gnat—The buffalo gnat (*Simulium pecuarum*) is a small fly which occurs most abundantly in the lower Mississippi Valley, and causes great annoyance to cattle in that region. The fly has a humpbacked thorax, which gives it its name, characterized by the peculiar short and thick shape. The head is bent down and is nearly as wide as the thorax. The color of the insect is black, and it is covered with grayish-brown silken hairs. The duration of an infestation of these flies varies from a few days to 5 or 6 weeks. The breeding places of this insect are tributaries to large rivers or streams. The eggs are deposited by the females in slowly running water. The developed maggots finally congregate in swift water, where they remain for nearly a year. For counteracting the poisonous effects of the bites of these insects the animals may be rubbed with water of ammonia or may be driven into cold streams. Smudges have proved the best method of protecting the animals in the fall against the buffalo gnat. Animals may also be protected with a layer of mud or a coat of syrup. Since the gnats have an aversion to entering dark places, animals may be kept in darkened stables during the gnat season. A number of external applications have a deterrent effect upon the flies. Decoctions of alder leaves, tobacco and pennyroyal have been used for this purpose. Experiments have shown that the best preventive is grease of different kinds, such as cottonseed oil, alone or mixed with pure fish oil, crude oil, axle grease, etc.

Scabies, or mange, is a disease of cattle due to a mite closely related to that which causes sheep scab, and occurs quite generally in Colorado, Wyoming, Montana, Kansas and Nebraska. The disease is first recognized by the cattle rubbing themselves against any accessible object. It appears first upon the neck and shoulders, but gradually extends over the larger part of the body. In Montana it has been known for 20 or 30 years, and affected buffaloes as well as domestic cattle. It may possibly have been transmitted originally from the buffalo to cattle. The only successful way for treating this disease on a large scale is by means of dipping. Dipping plants should be constructed similar to those used for treating cattle for ticks (see Fig. 346), and the dips to be used may be lime and sulphur dip, zenoleum or chloronaphtholeum. The lime and sulphur dip should be made of 21 pounds flowers of sulphur, 16¾ pounds unslaked lime and 100 gallons water. For method

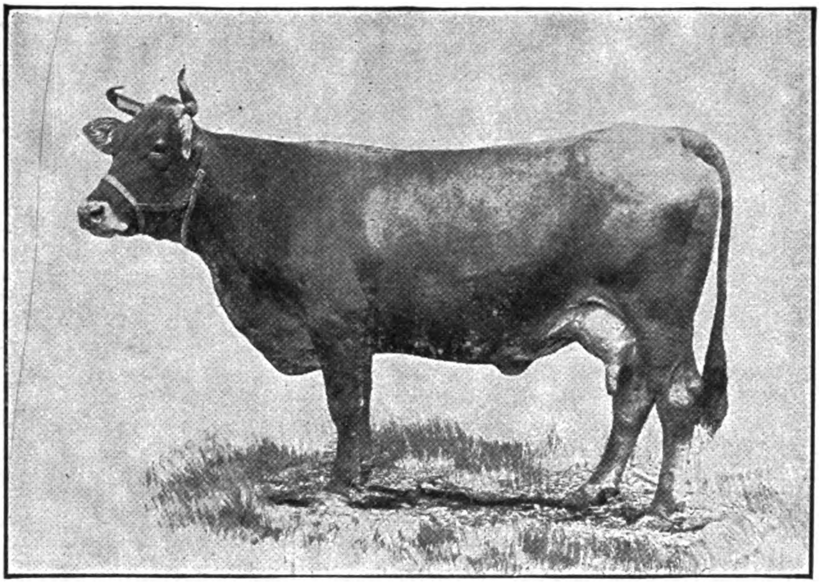

Fig. 350—BROWN SWISS COW

of preparing see *Sheep Scab* under *Sheep.* The zenoleum or chloronaphtholeum should be used in from $3\frac{1}{2}$ to 4 per cent solutions. Cattle should be dipped twice in the spring and also twice in the fall, the latter application being more important. The interval between the 2 dippings either in the spring or fall should be about 2 weeks.

DAIRY FARMING

Dairying, especially in the Northern and Eastern States, is one of the most important lines of animal industry. According to the preliminary summary of the census of 1900, the total value of dairy products in the United States for that year was nearly $131,000,000. This sum covers simply the butter, cheese and condensed milk made in factories. The States which furnish the greatest amount of dairy products are New York, Wisconsin, Iowa, Illinois, Pennsylvania, Michigan and Vermont.

Good dairy cows produce food in the form of milk more economically than animal products can be obtained in the form of beef, pork or mutton. Naturally the cost of production of milk and butter will vary in different localities according to the price of labor and feeding stuffs. In Minnesota the average cost of keeping a dairy cow was found to be $38 per year. In Massachusetts the average cost of producing milk was 2.3 cents per quart. About ½ as much feed is required for 1 pound of gain in steers as for 1 pound of butter from cows. In New York milk was produced for 65 cents per 100 pounds. The cost of the production of butter in different places varies widely, but usually between 8 and 12 cents per pound.

In making a practical start in the dairy business the first problem is the formation of a dairy herd. The selection of the cows and the bull is by no means an indifferent matter. It is usually recommended that a herd should not be composed of different breeds, but should contain only 1 pure breed and grades of that breed. For dairy purposes dairy breeds should be selected for the reason that they produce milk fat rather than body fat from their food, while beef types of cattle as a rule are likely to become fat under forced feeding without increasing their milk yield. One should not, however, allow either breed or type to determine his choice of cows for a dairy herd. The prime requisite is that they shall give a good quantity and quality of milk.

An average cow should yield 6500 pounds of milk and 300 pounds of butter per year. It will scarcely pay to keep for dairy purposes any cow which produces less than 200 pounds of butter per year.

After selecting a herd the milk of each cow should be weighed daily and should be tested from time to time with a Bab-

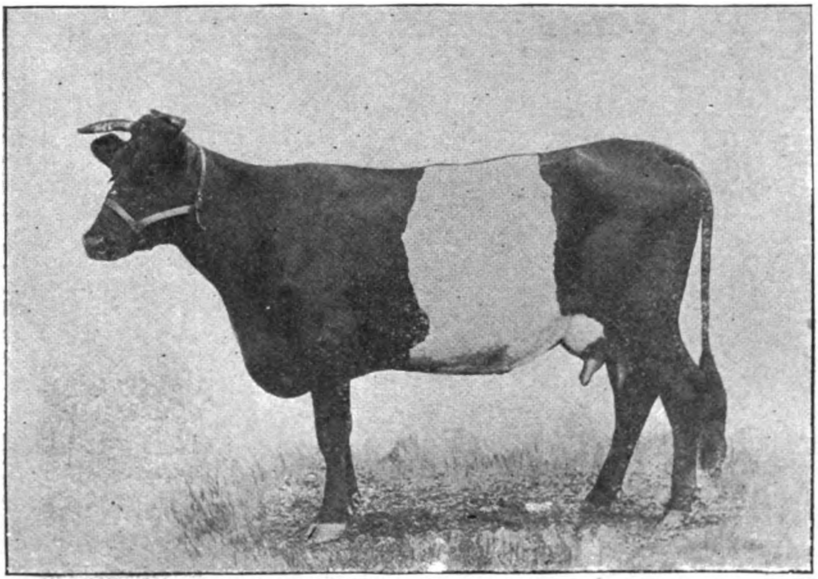

Fig. 351—DUTCH BELTED COW

cock tester. In this way the dairyman keeps himself informed as to the productiveness of different cows and may cull out from the herd such cows as are not paying for their keep. The bull is a very important part of the herd. By using a good bull an excellent and productive herd may ultimately be secured from an average lot of cows. For discussion of calves, combination of dairying and beef making, and temperature of cows, see *Cattle.*

Breeds—The breeds of cattle in this country most used for dairy purposes are Ayrshire, Brown Swiss (Fig. 350), Devon, Dutch Belted (Fig. 351), Guernsey, Holstein, Jersey, Normandy, Polled Durham, Red Poll (Fig. 352), Shorthorn and Simmenthalers. Some of these are not strictly of dairy type but are rather beef breeds. This is especially true of the Shorthorns and Polled Durhams. These latter breeds are briefly characterized under *Cattle.* Shorthorns are also very profitable for dairy purposes. In this place a few notes will be given on 4 only of the dairy breeds, viz., Jersey, Holstein, Guernsey and Ayrshire, mentioned in the order of their comparative numbers.

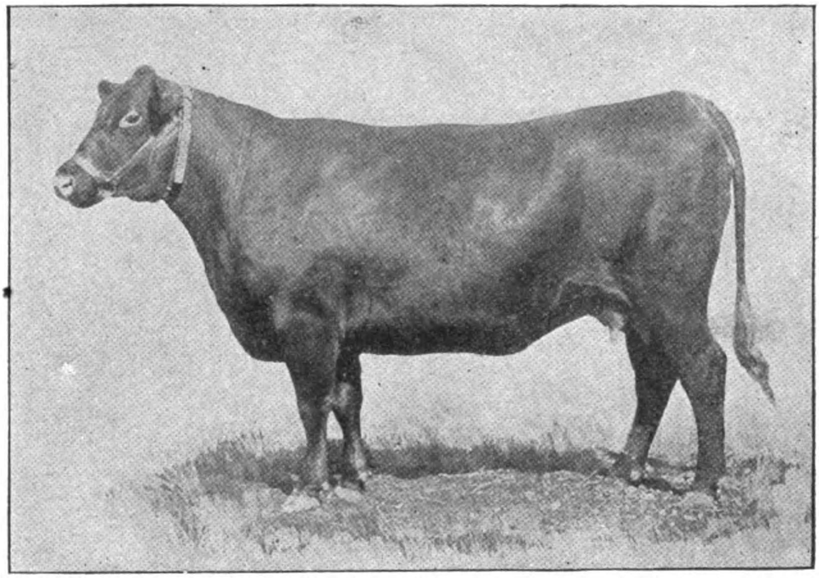

Fig. 352—RED POLLED COW

The JERSEYS (Figs. 353*a* and 353*b*) are the smallest of the dairy breeds, the cows weighing usually from 700 to 1000 pounds, and the bulls from 1200 to 1800. The color varies exceedingly, from brown to black and from shades of yellow through fawn and tan colors to creamy white. Solid colors are preferred by some breeders but the majority of Jerseys are variously marked. The breed is characterized by the high percentage of fat and other solids in the milk. Jerseys are heavy feeders and give a good account of their feed.

The HOLSTEINS (Fig. 354) are large for dairy breeds, the cows ranging from 1200 to 1500 pounds and the bulls often weighing 2500 pounds. The breed is distinguished by its pure black and white colors, the patches of each color being sharply defined. Holsteins are docile and are especially noted for their enormous milk yields. The average herd record is 7500 to 8000 pounds of milk per head per year and some cows yield as much as 30,000 pounds per year.

The GUERNSEYS (Fig. 355) are larger than the Jerseys and of stronger bone. The bulls are perhaps of better disposition than Jerseys. The color of the breed is light, chiefly yellow and orange with considerable white. There is an abundant secretion of yellow coloring matter on the skin particularly where the hair is white. The Guernseys are economic feeders and excellent butter producers, the milk often showing 5 per cent to 6 per cent of fat.

The AYRSHIRES (Fig. 356) are noted for their vigor and their ability to give good returns in milk and butter even under unfavorable conditions of pasture, etc. Cows average about 1000 pounds in weight and bulls range from 1400 to 1800 pounds. They are short in the legs, of small bone and active. It is frequently claimed that they give the best returns for their feed of all the dairy breeds. The predominating colors are red and white, variously arranged in spots but not mixed. The cows are of a very nervous temperament and somewhat quarrelsome.

For the general differences between dairy and beef breeds see *Cattle.*

Numerous experiments have been made for the purpose of determining whether a particular breed is uniformly better for the production of milk, butter or cheese than the other breeds. The results of these experiments, as well as the claims of the admirers of different breeds, are so much at variance that no unqualified recommendations can be made along this line. The choice of a breed for establishing a dairy herd will depend, therefore, in large part on the personal taste and preferences of each individual. The following data from experiments in comparing breeds may be suggestive.

In a series of experiments at the Cornell Station it was found that individual cows of the same breed vary more in milk and butter production than do different breeds. At the Storrs Station experiments showed that "the type of a cow is a much better index of her ability for economical production than is her pedigree." Cows of good dairy type were more productive than other types without regard to breed. In Wisconsin a comparative test of the average daily milk yield gave the following results: Holstein 48.9 pounds, Brown Swiss 37.3 pounds, Shorthorn 31.9 pounds, Guernsey 28.9 pounds, Ayrshire 27.7 pounds, Dutch Belted 27.2 pounds, French Canadian 27 pounds, Red Polled 26.6 pounds, Jersey 24.5 pounds, Polled Jersey 22.9 pounds, and Devon 11.8 pounds. In a test of the percentage of fat in the milk of different breeds, the Jersey stood at the head, followed by Guernsey, Polled Jersey, Devon, French Canadian, Ayrshire, Red Polled and Shorthorn. In a comparison of the cost of feed per quart of milk at the New Jersey Station it was found to cost 1.66 cents to produce a quart of milk from Ayrshires, 1.71 cents from Guernseys, 1.71 cents from Shorthorns, 1.75 cents from Holsteins and 1.91 cents from Jerseys. The cost of a pound of butter fat was 15.3 cents from Guernseys, 17.9 cents from Jerseys, 20.6 from Ayrshires, 20.8 from Shorthorns and 22.4 from Holsteins. At Toronto the breeds ranked as follows in quality of milk: Aberdeen-Angus, Hereford grade, Shorthorn grade, Ayrshire, Hereford and Shorthorn. In relative profit from milk at the New York State Station the

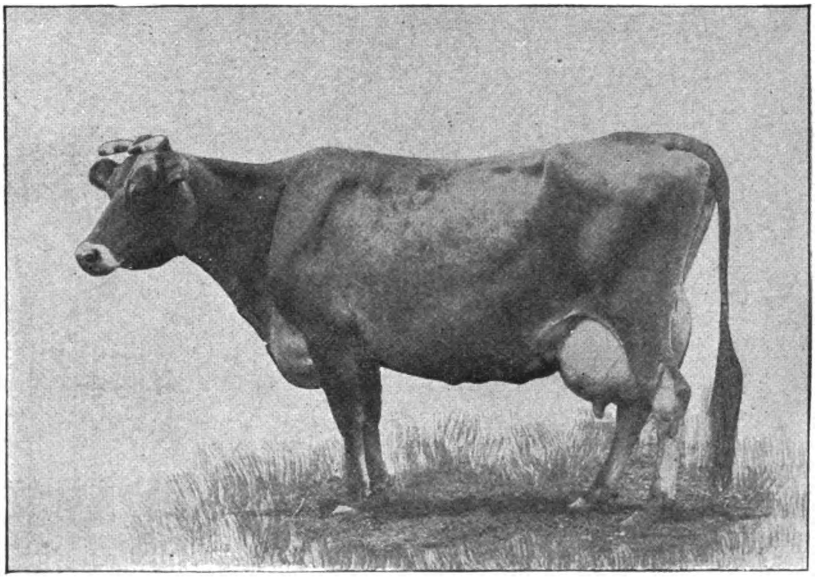

Fig. 353*a*—CHAMPION JERSEY COW

breeds ranked as follows: Holstein, Shorthorn, Ayrshire, Guernsey, Jersey and Devon. In relative profit from butter the breeds stood in the following order: Guernsey, Jersey, Shorthorn, Holstein, Ayrshire and Devon. In relative profit from cheese the breeds ranked as follows: Shorthorn, Guernsey, Jersey, Holstein, Ayrshire and Devon. In Iowa the cost of butter per pound was 10.4 cents from Jerseys, 12.7 from Shorthorns and 12.8 from Holsteins. In a test at the New Jersey Station the percentage of fat in milk from Guernseys was 5.02, from Jerseys 4.78, Ayrshires 3.68, Shorthorns 3.65, and Holsteins 3.51.

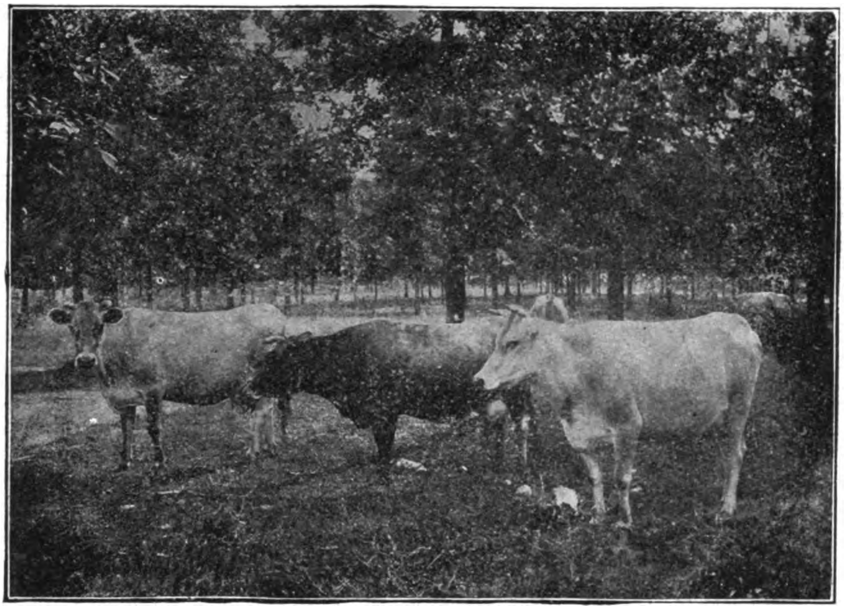

Fig. 353*b*—HERD OF JERSEYS
(From O. E. S. Bul. 80, Plate 27, Fig. 2)

These experiments show that dairy cows should be selected not for their breed but for their ability to produce milk and butter in large quantity and with good profit for the feed consumed.

Effect of Dehorning—This operation is generally recommended by those who have tested the matter. Unruly cows are rendered docile and easily managed and there is less danger of injury to one another and to attendants. Only a slight check is observed in the milk flow from dehorning and the full yield is regained within a week or 10 days. In Minnesota the unfavorable effect on the milk yield was as marked in cows which merely saw the operation and smelled the blood as in cows which were dehorned. For details of the operation of dehorning see under *Cattle.*

Effect of Tuberculin—Under ordinary conditions tuberculin tests have no effect on quantity or quality of the milk of healthy cows. All cows should be tested at least twice per year. For tuberculin and tuberculosis see *Cattle.*

Value of Shelter—Dairy cows require more shelter than beef animals, but shelter must not be furnished in the form of unsanitary confinement. Stables for cows should have no cellar under them or storage above the cows. There should be no material in them which may absorb odors from the cows or develop bad odors by decomposition or fermentation. If stables are used exclusively for stables they may be easily cleansed and disinfected at frequent intervals by use of whitewash or other material. The stable should be in immediate connection with the barn in which the feeding stuffs are stored. We cannot in this work describe model arrangements which should be found in a dairy barn and stable. The ruling idea in the construction of the barn should be convenience in storing and handling feeding stuffs, while the stable should be built with a view to securing the greatest possible cleanliness of the cows and their surroundings.

In Indiana it was found that cows ate more and gave less milk when exposed to severe weather than when kept in stables. Cows out of doors also lost weight. In Massachusetts warming the stable had little influence on the yield of milk and butter. Stabling cows to protect them against flies in summer was found to have no advantage in Wisconsin. In Arizona cows exposed to winter rains showed a decrease of from 10 to 50 per cent in milk flow, and required a month to return to their normal yield. Exposure to summer rains also had a bad effect. In the dry cold weather of winter more feed was required than in warm weather.

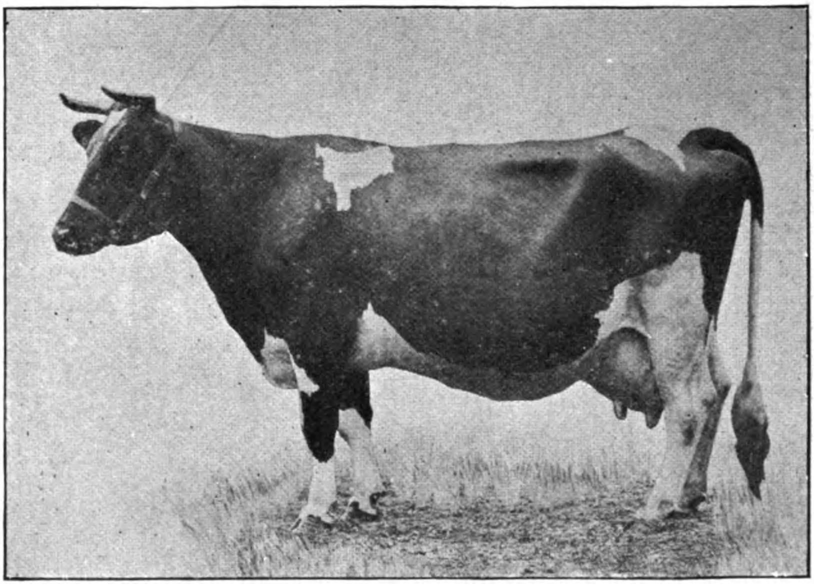

Fig. 354—HOLSTEIN-FRIESIAN COW

Feeds and the Time of Year—Experiments at the New York Station showed that cows required the greatest amount of feed in July, when the quantity was nearly 3 times as much as in May. The amount required for June and September was about the same but less than for July.

Relation of Amount of Feed to Economy of Production—As a rule cows which eat the most feed produce the most milk and butter, and make these products most economically. This fact has been demonstrated in New York, Pennsylvania, and in an official test at the World's Fair in Chicago. The feeding power of cows is therefore an important matter to be considered in selecting or breeding up a dairy herd.

Age and Productivity of Cows—Dairymen usually find that the milk yield increases up to about 7 years of age, after which it remains nearly constant until about the 12th year, when it begins to decrease more rapidly. The average dairy cow is at her best between the ages of 7 and 10 years. There is usually a slow and gradual decline after the seventh year of life until the 12th year, after which the cow may be less profitable than heifers. After their period of profitable milk production is passed, dairy cows should be kept dry and fattened for beef. At the Cornell Station it was found that the cost of milk was greatest in 2-year-old heifers and decreased up to 4 years of age, after which it remained constant. The gain in milk yield between the ages of 2 and 3 years was 5 per cent, between 3 and 4 years 18 per cent, and 15 per cent between 4 years and the age of greatest production. At the Ohio Station it was shown that the cow gives a constantly increasing milk yield for a given amount of feed up to 7 years of age, after which a slow decline was observed until the 11th year of age.

Relation of Size of Cows to Milk Yield—In a comparison of light, medium and heavy cows at the exposition in Chicago, as reported by Woll, the light cows yielded the least milk and butter and their feed also cost least. The results were slightly in favor of the heavy cows. Some German experiments indicate that the milk of small cows is richer in fat but that the quantity is relatively smaller than in large cows. The latter eat less feed per 1000 pounds live-weight than small cows.

Period of Lactation and Milk Yield—Experiments in New York, Wisconsin and Ohio show that the greatest production of milk fat takes place soon after calving and that the flow is gradually diminished. The New York State Station found that the milk yield for each month was about 9 per cent less than that of the preceding month.

Fall Calving—There are many advantages to be derived from having the calves come in the fall. The greatest milk yield is obtained if proper feed and care are provided during the winter. The highest prices are obtained for milk and butter in winter. Cows which calve in the fall may obtain fair feed on pasture and this may be supplemented by soiling or feeding silage. Silage and roots may be fed during the winter, and a fresh flow of milk may be induced by turning the cows to pasture in the spring. In winter the farmer has less exacting work to take his attention from the necessary care of the cows than in summer. Fall calving is also better for the calves. They are less subject to scouring in winter than in summer and spring pasture is ready for them by the time they are weaned. They, therefore, suffer no check in growth, and may be conveniently and profitably forced for the production of "baby beef." (See *Cattle.*)

Treatment of Cows Before and After Calving—As a rule the greatest total milk yield for the year may be obtained by drying off the cows from 6 to 8 weeks before calving. This may be accomplished with most cows by withholding the stimulating grain ration, milking once per day and later every other day. Attention must be given to the condition of the udder during this period so as to prevent inflammation. Some cows, however, apparently cannot be made to go dry and do not require the period of rest before calving. At this time the bowels should be kept loose. A good grain ration for a few days before calving is a mixture of 2-3 bran and 1-3 linseed meal. This mixture may also be

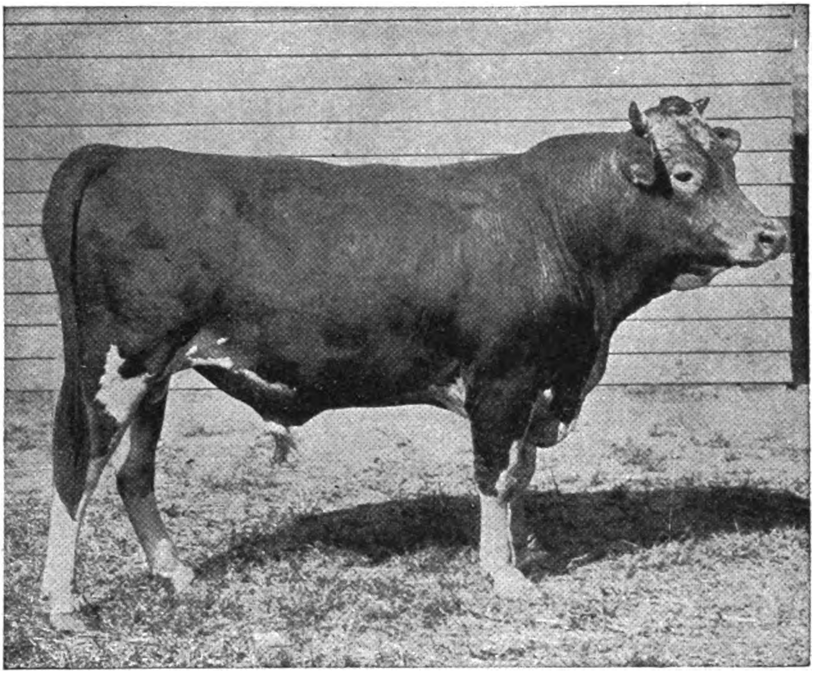

Fig. 355—CHAMPION GUERNSEY BULL, BUTTER BOY

continued for the first 2 weeks after calving. The roughage may be alfalfa or clover hay and roots.

After calving the cow should be kept warm, by blanketing if necessary, and should not be allowed to drink ice cold water until the afterbirth has come away. If this does not occur for 24 to 48 hours after calving, it should be carefully removed by hand. A vaginal douche of a dilute solution of permanganate of potash (5 to 10 grains in 1 quart of water) may be given to prevent any irritation or rise of temperature. The calf should be allowed to suck the cow for 4 or 5 days, after which he may be separated from the cow and fed at first on whole milk and then on sweet skimmilk and grain. (See under *Cattle.*)

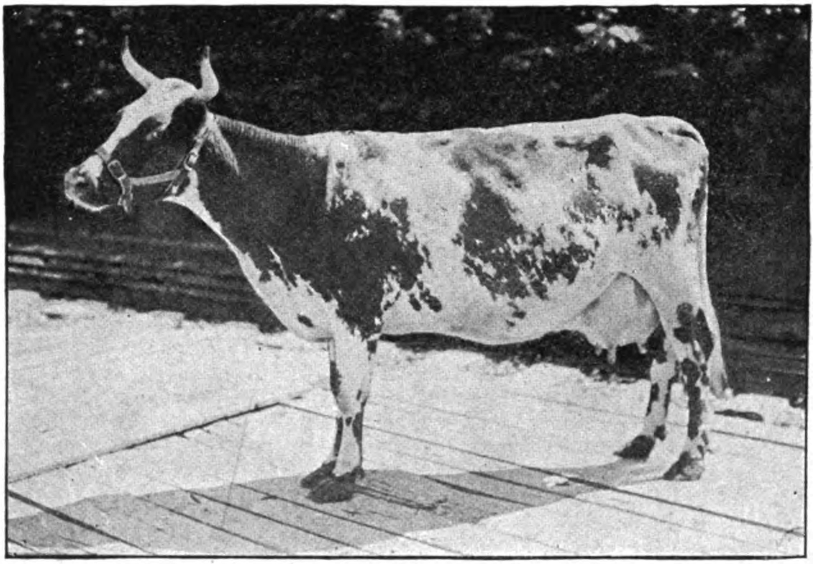

Fig. 356—TYPICAL AYRSHIRE COW

If a case of caked udder or garget develops the cow should be milked frequently, say at intervals of 2 hours, but not dry. Epsom salts may be given as a laxative in a dose of 1 to 2 pounds dissolved in water. It may become necessary to make moist, hot applications to the udder. (See *Mammitis* under *Cattle.*)

Exercise—It is generally recognized that for the best results with cows some exercise is necessary. In summer this is easily provided in pasture, or feed lot if soiling is practiced. In winter it may be necessary to provide sheds in which the cows may move about, protected from too great exposure to cold. No animal can maintain a good state of health and vigor for 10 or more years without some regular exercise. The percentage of tuberculosis in dairy cows is far greater than in beef cattle, and this is partly due to excessively close confinement of the dairy cows.

Kindness, Regularity, etc.—The high bred dairy cow is of a nervous temperament and any fright or excitement from rough treatment or other annoyances has the effect of lowering the milk yield. Moreover the flow of milk is favored by regular hours of feeding, milking, grooming, etc. There should be no unnecessary changes in the attendants who feed and milk the cows.

Care of the Bull—The bull should be given plenty of exercise and nitrogenous feeds. He should be kept at pasture for the greater portion of the year, in a field by himself, and in winter may be allowed the run of a small lot with shed protection from storms. Vigor and not fat are desired in a bull. He should therefore receive good roughage in the form of alfalfa or clover hay and bran, oats, peas or barley rather than corn. The bull is perhaps at his best between the ages of 2 and 5 years, but may be useful for a few years longer if not allowed to become run down by overservice.

Pasture—Almost every farm has 1 or more pasture lots. Pastures may be seeded to cultivated grasses and in the arid regions may be irrigated, or they may represent waste areas which cannot be tilled. While pasturage is at its best a good milk flow can be maintained with only small grain rations. Experiments indicate, however, that it is always desirable to feed some grain to cows at pasture, even when the grass is greenest and most succulent. Pasture may be re-enforced at any or all times by feeds of soiling crops after milking, and when the pasture becomes short the rations of green crops must be correspondingly increased. The chief advantages of pasture are that the cows secure succulent feed under cleanly and healthful conditions combined with a proper amount of exercise. Close attention should be given to the cows late in the season, since wild pastures may suddenly become quite inadequate for the maintenance of the milk flow in periods of drouth. For grasses suitable for improving pastures see under *Grasses* and *Meadows*. A change from dry feed to pasture or vice versa should always be made gradually so as not to interfere with the milk flow.

In Canada pasture produced more and better milk than soiling on alfalfa, rye and oats. At the Vermont Station it was shown by experiments extending over a period of 6 years that a change from barn to pasture produced an increase in the solid matters in milk, especially in new milch cows. In New York drouth affected cows on pasture by diminishing the casein and increasing the fat in the milk. There were greater returns from stall fed than from pastured cows. At the New Hampshire Station it was found that pasture grass increased the quantity of milk and its fat content. In Utah grazing on pasture of mixed grasses under irrigation proved to be the most economical way of producing milk. A change from dry feed to pasture gave a greater increase in milk than a change to soiling. The composition of the milk was not affected by pasture.

Soiling—This practice has long been familiar to farmers, but has greatly increased of late years and found many enthusiastic advocates. In farming regions where the price of land is high it does not pay to leave arable land in pasture, since from 2 to 3 times as much green forage can be obtained by soiling as by pasturing. By a system of soiling a continuous supply of succulent material may be secured from May 1st to November 1st. No check in the flow of milk need, therefore, be suffered. For details of the practice see under *Soiling*.

In Connecticut it was found that soiling was always necessary to help out when pasture was short. Legumes like clover, peas and soy beans proved better than corn fodder and other soiling crops. In Iowa soiling proved superior to pasture. Cows ate about 75 pounds of green feed per day in addition to grain. In Massachusetts rye, vetch and oats, peas and oats, corn fodder, and serradella are recommended for soiling, and in New Jersey rye, corn, crimson clover, oats and peas, and millets. In Pennsylvania the cost of soiling proved so great that good prices for milk were necessary to make it pay more than pasture. At the Wisconsin Station 3 times as much milk was produced by an acre of soiling crops as by an acre of pasture.

Silage—If a constant supply of green forage is required the year around it is highly desirable to make silage. For the preparation of silage and the construction of silos see these subjects. Silage properly prepared and stored may be kept in a wholesome condition for several years. It may, therefore, be fed in summer or winter. Silage is palatable, maintains a good milk flow and has no injurious effect upon the milk. Forage crops suitable for soiling are also suitable for silage, but corn is the chief silage crop. A given amount of fodder can be harvested and fed more cheaply in the form of silage than as hay or by a system of soiling. This is one of the chief advantages of silage. It is often inconvenient for the farmer to take the necessary time each day for cutting and hauling green fodder, but silage is always convenient. From 30 to 35 pounds of silage per day is a good feed for cows weighing 1000 pounds.

Roots add succulence to the ration and have an appetizing effect. They may be kept for feeding in winter without expense, save a cellar for storing. Some roots, like turnips, cannot be fed except in limited quantities on account of bad flavors which they give the milk. Moreover, it has been clearly shown that forage can be produced and fed more cheaply in the form of silage than in the form of roots.

In New York roots produced a yield of milk and butter about equal to that from silage. In Iowa, when roots were left out of the ration the percentage of milk fat decreased, and the cows did not gain in weight. Roots appeared to be superior to corn fodder, corn silage or sorghum silage for milk production. At the Massachusetts Station, when roots were added to the hay ration the milk yield was increased, but at too great a cost. The milk yield was likewise increased in New Jersey, but the composition of the milk was not affected.

Forage Crops and Roots for Cows—Notes will be given in the following paragraphs on various forage and root crops suitable for dairy cows. The crops are arranged alphabetically, forage plants first, followed by roots.

ALFALFA is one of the most important forage plants for cows in the arid regions. It may be pastured or fed as hay or a soiling crop. In Canada alfalfa was eaten with more relish than green rye and gave the butter a better flavor. In New York alfalfa produced more milk than any other green forage or silage. The quality of the milk was sometimes poorer than that of milk from corn fodder or silage. Alfalfa proved superior to mixed hay in Utah, and was cheaper and more effective than corn fodder. In New Jersey it was found that alfalfa hay could be substituted for wheat bran or dried brewers' grains in rations for dairy cows.

BERMUDA GRASS HAY has been found equal to timothy for milk production.

BROME GRASS starts early in the spring and is much relished by cows. In Nebraska brome grass pasture proved to be not quite equal to alfalfa or to a mixture of blue grass and white clover.

CLOVER occupies the same place in the Eastern half of the country as does alfalfa in the West. It may be pastured or fed green, as hay or as silage. In Vermont clover silage proved unequal to corn silage. At the Storrs Station clover was found to be superior to Hungarian grass for milk and butter production. Red clover proved about equal to peas and oats as a soiling crop in Iowa. At the Massachusetts State Station rowen equaled peas and oats, but the cost of milk production on rowen was higher than on green vetch and oats or on green fodder corn. In Michigan clover silage was relished and kept well, but nothing is added to the feeding value of clover by ensiling it. In Wisconsin 1 ton of clover hay was found equal to 3 tons of cornstalks.

CORN furnishes the most important roughage for dairy cows and more experiments have been made with it than with any other crop for this purpose. Most silage is made from corn. It is usually desirable to feed some hay along with corn silage.

In Canada corn silage fed in quantities up to 60 pounds per day made butter equal to that from mixed coarse fodder. It is recommended, however, that not more than 50 pounds of silage be fed per day to each cow. A larger percentage of fat was recovered in setting milk from cows on Robertson's mixture than from those on corn silage.

In Vermont corn fodder (stalks and ears) and silage proved about equal, the silage being slightly better on the whole. Both were better than corn stover (stalks without ears). Green sweet corn fodder was better relished than dent corn and gave a better yield of milk. Dent corn produced more forage per acre, however, and was more economical. The butts of corn stover were found equal to the tops, and stover equal to timothy hay. Silage proved better than hay in one test at the same station and inferior in another. Silage from frosted corn was found inferior to that from unfrosted corn. In 1891 corn silage made more milk, but of a poorer quality than that from corn fodder. Silage appeared to be superior to green corn fodder. Whole silage, stover silage, corn fodder and stover were all relished by cows, and the quality of the milk was the same from all 4 forms of the corn crop. About 3 per cent more milk was obtained from whole silage than from stover silage, and a similar difference was noted between fodder and stover. For milk production it was found that 1 acre of corn made into whole silage equaled 1.26 acres of stover or stover silage and 1.08 acres of corn fodder. Whole silage and stover silage were better relished than corn fodder or stover, and the relative cost of preparing and feeding the 4 forms of the crop was greatly in favor of whole silage ("ears and all").

At the New York State Station corn silage caused an increase in yield of milk and butter and economy of production. In Iowa corn fodder made more butter and at less cost than roots, but silage made a poorer showing than corn fodder. Sweet corn proved inferior to peas and oats, red clover, soy beans or cowpeas as a soiling crop, but the butter from the sweet corn scored higher than that from any other soiling crop. In Michigan silage was found more economical than corn fodder and superior to roots.

According to experiments at the Maryland Station there is least loss in feeding corn fodder, shredded, mixed with the grain ration and wet. In Massachusetts corn stover or silage produced milk more cheaply than hay. Fodder, stover or silage was more effective than hay. Silage gave the best results when fed in rations of 35 to 40 pounds in addition to hay. It was found that a too exclusive ration of corn silage badly affected the general condition of the cows. The Minnesota Station recommends dent corn for silage. Dent, sweet, Southern and flint corn were found about equal, dent being slightly in the lead. In New Hampshire a change from dry corn fodder to silage increased the quantity of the milk and the fat content. Silage was found to produce a softer butter than hay, but of better flavor, and was far more effective than hay. In one test in Missouri corn fodder was found superior to silage.

In New Jersey the cows showed no preference between green and dry corn fodder and silage. Silage, however, was decidedly more effective than fodder or roots, both in milk yield and in maintaining the weight of the cows. In one test at the same station the cost of harvesting, storing and feeding dry fodder was less than that of silage. In Pennsylvania it was found that dent corn, cut when the kernels were mostly dented, and the leaves and husks were mostly green, made more butter fat than an equal amount cut earlier or later. The yield per acre is a little less when cut early. Corn fodder and silage proved equal in every respect in milk production in Ohio and Pennsylvania. The Ohio Station recommends that silage should be made before the corn is fully mature.

At the Wisconsin Station it was shown by experiments extending over several years that silage is somewhat more effective in milk production than dry corn fodder. Cows sometimes ate more silage than fodder. The milk flow was generally greater on silage and the milk was sometimes richer, sometimes thinner. Silage and fodder proved equally digestible. Siloing is considered the most economical way of handling the corn crop for dairy cows. Smutty corn proved fatal in Wisconsin, while in Michigan it was fed with impunity. Corn fodder allowed to stand in the field is not so effective as when cut.

Cowpea—This is a very important crop as pasture or silage for cows, especially in the Southern States. In Mississippi cowpea hay proved equal to Johnson grass hay. In Nebraska cowpea pasture made a large yield of milk and butter. At the Delaware Station cowpea silage proved almost equal to the best June pasture. A ration of 25 pounds of the silage and 6 pounds of hay was found excellent for winter feeding. The silage proved slightly superior to wheat bran for milk production and the quality of the butter was equal to that from bran.

The Flat Pea (*Lathyrus sylvestris*) was not relished by cows at the Michigan Station, either as a soiling crop or as silage. The cows lost weight on it and the milk flow decreased.

Hay enters into all rations for dairy cows except when they are on pasture or soiling crops. Hay in the Northern and Eastern States is usually made of timothy and clover. At the Maine Station, when a change was made from a ration of 13 pounds of hay and 25 pounds of corn silage with grain to 8 pounds of hay with the rest of the ration unchanged, a smaller milk yield, loss of weight and unthrifty condition were observed. A change from hay to silage caused an increased production of milk. The opposite change in New Hampshire produced the opposite effect. In Massachusetts salt marsh hay was found somewhat less effective for milk production than ordinary hay. When fed after milking no flavor was given to the milk. The percentage of milk fat was somewhat less than on ordinary hay. Marsh hay, however, is so much cheaper than ordinary hay that a most economical and effective ration may be made of 12 pounds of salt marsh hay and 1 bushel of silage per day. In Sweden it was found that marsh grass silage, fed in rations not to exceed 20 pounds per day, was about equal to beets.

Kafir Corn fodder or silage is relished by cows and has been found to be nearly equal to corn.

Lespedeza hay in Mississippi was found to be superior to either timothy or Bermuda grass hay.

Millet silage was much relished by cows in Michigan and had a good influence on the milk flow. In North Carolina, however, millet hay, added to a ration of corn silage and grain, had no apparent effect on the yield of milk. Hungarian silage was greedily eaten at the Vermont Station and was equal to hay but inferior to corn silage.

OATS AND PEAS, green or as silage, are usually combined. Oats and peas at the Toronto Station yielded more per acre than oats and vetch, but the 2 combinations were equally effective as milk producers. In Vermont oat and pea hay was not much relished, but when eaten gave better results than any other coarse fodder. Oat, pea and vetch silage was apparently superior to corn silage. In Nebraska oats and peas made the best medium early pasture for milch cows. At the Storrs Station they proved to be the best forage crop for midsummer. Oat and pea silage is highly recommended by the Michigan Station. In New Hampshire oat hay alone proved inferior to timothy and clover in milk production. At the Maine Station pea, sunflower and corn silage was found superior to corn silage. This mixture cannot be used to replace all of the grain ration, but 20 pounds of the mixture may be substituted for 3 pounds of the grain. Pea silage is recommended in Minnesota and Tennessee.

RAPE is a promising silage for dairy cows. As a rule it produces a good flow of milk, but must be fed with some caution, since it may taint the milk. In Canada 55 pounds of rape per day made slightly more milk than corn silage and the milk tested a little higher. The milk had a rape flavor, however, and cheese made from it was gassy. In Iowa the yield of milk and butter decreased when cows were taken from pasture and fed rape as a soiling crop. The butter was of poor quality. In Michigan rape silage was greedily eaten by cows and no taint was imparted to the milk.

ROBERTSON'S MIXTURE SILAGE is highly recommended in Canada, and has been tested in this country, especially at the Vermont and Maine Stations. In one test it proved equal, and in another decidedly superior to corn silage. Robertson's mixture and corn silage together were found equal to beets and carrots for the production of milk. The mixture may be substituted for a part of the grain ration without loss in weight or milk production. For the preparation of Robertson's mixture see under *Silage*, also *Sunflowers*.

RYE may be used for pasture, silage or as a soiling crop. In Canada it proved to be inferior to alfalfa in yield per acre, milk production and palatability. In Vermont rye silage was found to be drier, less readily eaten and made 10 per cent less milk and butter than corn silage. In Alabama, however, rye gave better results than silage in milk production. At the Storrs Station it was found the earliest available soiling crop. Rye is recommended for pasture in Nebraska.

SERRADELLA in Massachusetts greatly increased the milk flow when substituted for ¾ of the hay ration. Cows ate from 90 to 97 pounds of green serradella per day.

SORGHUM, among other crops tested in Nebraska, furnished the greatest amount of pasture. In Michigan sorghum fodder and silage were readily eaten by cows, but were not equal to corn. Sorghum silage was found to be an economical feed in Tennessee and much superior to cottonseed hulls in Georgia.

SOY BEANS ensiled with corn did not materially improve the silage or increase the milk flow over that obtained from corn silage in Vermont. Soy bean-cowpea silage made less but richer milk. The mixed silage was less relished and more expensive to produce. In Nebraska soy bean pasture considerably increased the production of butter fat. In Massachusetts soy beans were found to be superior to peas and oats for soiling. Soy bean and corn silage increased the milk yield over hay.

TIMOTHY is a poor dairy feed, and as a rule should not be used for that purpose. In Minnesota it was found to be a less economical feed than prairie hay, while in one test it seemed to be superior to silage. At the Storrs Station both timothy and redtop proved to be unprofitable feed for dairy cows, and it is recommended that they be replaced by leguminous hays.

VETCH is considerably used in mixtures for soiling and is valuable for that purpose. In New Hampshire vetch hay proved rather superior to timothy and oat hay.

WHEAT at the Storrs Station was found to be, next to rye, the earliest available crop for soiling. Wheat is better than rye and can be fed for a longer time.

APPLES, especially windfalls or diseased specimens, are sometimes fed to dairy cows, but they have little feeding value. In Canada apples were unequal to apple pomace for maintaining the milk flow, and the milk was tainted. In

Vermont ensiled apple pomace proved equal to corn silage in tests covering a period of 4 years. No care was required in ensiling the material. Apple pomace was fed in rations of 15 pounds with good results.

ARTICHOKES in a test at the Vermont Station showed a feeding value about equal to corn silage.

BEETS—In experiments at the Ohio Station field beets made more milk than corn silage, but did not sustain the weight of the cows so well. In other tests beets seemed slightly superior to silage. They increased the consumption of other feeds. As a result of all experiments it was concluded that field beets are about equal to corn silage, but more expensive to produce.

CABBAGE was greedily eaten by cows in Iowa and increased the yield of milk and butter. The butter from cabbage did not keep well.

CARROTS, when used in Massachusetts to replace a part of the hay ration, increased the milk yield more than corn silage.

MANGEL WURZELS were found to be equal to sugar beets as milk producers in Canada. In Iowa more milk was obtained from mangel wurzels than from sugar beets, red table beets or turnips. The fat content of the milk, however, was less than that from turnips. In Massachusetts they proved inferior to corn silage for milk production, while in Michigan they seemed to lessen the digestibility of other parts of the ration.

POTATOES—In experiments at the Vermont Station potatoes were eaten more freely than silage, but were slightly inferior in effectiveness. Butter from potatoes was salvy and did not keep well. It was also shown that potatoes at a higher price than 15 cents per bushel are a more costly feed than silage. The Iowa Station found that high grade butter could not be made from cows eating more than 10 pounds of raw potatoes per day. Butter from potatoes is colorless and lacks keeping qualities. In Michigan potatoes lessened the digestibility of other parts of the ration. According to French experiments, dairy cows may be fed an exclusive ration of potatoes with increase in milk flow but loss in weight. No apparent effect on the quality of the milk or butter was noted from feeding potatoes in Michigan.

PUMPKINS—At the Vermont Station pumpkins, as compared with silage, made from 1 to 2 per cent less milk and butter. It appeared that 2½ tons of pumpkins were equal to 1 ton of silage. The quality of the milk was not affected and the cows were not harmed by feeding pumpkins. In Germany pumpkins made less milk but more butter than mangels.

SUGAR BEETS proved equal to mangels as milk producers in Canada, but inferior in Iowa. It was found that the highest grade of butter could not be made from cows eating 20 pounds of sugar beets per day. The butter was of good color, however, and kept well.

In Massachusetts sugar beets, used to replace part of the hay ration, increased the milk flow more than corn silage. In Oregon they proved equal to carrots and superior to mangels in the flavor imparted to the butter. At the Cornell Station sugar beet pulp was fed in rations of 50 to 100 pounds per day. It was found that partly dried pulp was equal in feeding value to corn silage. As it comes from the factory, however, its value for milk production is about ½ that of silage. In Denmark it was found that butter from sugar beet pulp was equal to that from mangels and that 12 pounds of pulp equaled 1 pound of mixed barley and oats. In Colorado, sugar beet pulp showed a feeding value of $2.61 per ton and sugar beets $5.06 per ton in milk production.

TURNIPS—At the Toronto Station turnips, at the rate of ½ bushel per day, gave no flavor to the milk whether fed before or after milking. When 1 bushel per day was fed a turnipy odor appeared in the milk upon heating to 110° F. The odor was more pronounced when the turnips were fed before milking. The turnipy flavor was removed by pasteurizing the milk. Turnip tops were fed with good results in milk yield. In Iowa more milk, but of a poorer quality, was obtained from turnips than from mangels. In Norway turnips to the amount of 2.8 bushels per day gave no taint to the milk.

Miscellaneous Feeds, Salt and Water—Brief notes may be given on these subjects in the following paragraphs:

CANE SUGAR added to the rations of dairy cows had little effect on the quantity of the milk and none on the quality as tested at the Vermont Station.

CONDIMENTAL FEEDS have been tested at the Connecticut, Maine and Massachusetts Stations and elsewhere. They have all been shown to be valueless.

The claims made for such feeds are absurd and the prices extravagant.

Bone Meal was tested at the Vermont Station. When added to rations of dairy cows it had little effect on the ash content of the milk, but increased the quantity of phosphoric acid.

Skimmilk may be profitably fed to dairy cows. It has a favorable effect on the churnability and quality of butter fat. In Sweden clabbered skimmilk was found of little value for that purpose.

Oils have been fed to cows to determine whether the yield of milk and butter might be thus increased. In Vermont it was found that unemulsified cottonseed oil, when added to the ration, increased the milk yield 3 per cent and the total solid content 5 to 10 per cent. Emulsified oil increased the milk yield 4 to 9 per cent and the total solid content 2 to 15 per cent. Emulsified corn oil, palm oil and linseed oil had similar effects. In Maine it was found that an increase of food fat caused an increase in the milk fat. According to investigations in Massachusetts, New Hampshire, Denmark and Sweden, cottonseed oil, corn oil, palm oil, cocoanut oil, oleo oil and stearin temporarily increased the fat in milk. With the continuance of such feeds, however, the milk soon returns to the normal composition. At the Cornell Station tallow fed for 10 days in rations of 2 pounds did not increase the milk fat. Heavy feeds of oil derange the digestion and the butter may be so affected as to be virtually adulterated. Since the effect of oils is only temporary, there is no economy in feeding them. (See also *Rations* below.)

Salt is a necessity with dairy cows as with other animals. A supply of salt should be constantly accessible to the cows. It may be furnished granulated or in large pieces of rock salt. In Canada, when salt was withheld from the cows, the average loss in the milk yield was 14.5 per cent. Similar results were obtained at the Mississippi Station.

Water—An abundant supply of fresh, pure water should be always accessible to milch cows. Cows may be expected to drink from 60 to 100 pounds of water per day, according to the ration. At the Vermont Station cows allowed to drink at will gave 2 per cent more milk than when watered at intervals. The quality of the milk was poorer when cows were watered in stanchions than when watered in the yard. Several stations have tested the value of warming the drinking water for cows. As a rule no advantage has been found in this operation, the results being in some cases slightly in favor of warm water, in others in favor of cold water.

Grains—The best results cannot be obtained from milch cows without feeding grain. Even when cows are on the best pasture or are fed soiling crops in large rations, the addition of grain increases the milk yield. With cows on good pasture the effect of the grain may not be apparent at first. But as the pasture becomes short the grain rations may be increased and will have more uniformly beneficial effects in cows which are already accustomed to grain feeds. In order to secure the largest total milk yield, the cows should be stimulated to the best possible flow of milk during the early stages of lactation, and this flow should be maintained by judicious grain rations.

As a rule nitrogenous grains are more effective in milk production than corn. The ability of different cows to make profitable use of grain varies greatly. The grain rations may vary in size from 2 to 12 pounds per day, but only the best dairy cows can utilize large grain rations.

At the Vermont Station some cows on rations of 6 to 14 pounds of mixed meal per day gained in quantity and quality of the milk. Especially the milk sugar was increased. Other cows, however, got off feed or showed no change. Cows gave 1-3 more milk and butter fat on full grain rations than without grain. Better results were obtained from heavy than from light grain feeds. Only good cows, however, were able to utilize 8 to 12 pounds of grain per day. Experiments at the Cornell, Kansas, Mississippi and North Dakota Stations indicate that the immediate results from feeding grain to cows on good pasture are not striking, but that the weight of the cows is better maintained on grain, and beneficial results are seen in the flow of milk late in the season. Similar results were obtained in Utah. The Wisconsin Station found that it did not pay to feed more than 8 pounds of grain per day. A ration of 12 pounds was fed at a loss, and the after effects were bad. At the New Jersey Station 10 pounds per day was found the largest profitable grain ration, while in Utah 8 pounds is considered as the outside limit of a grain ration, and feeds of more than 6 pounds increased the cost of the milk.

In Massachusetts, with cottonseed meal, linseed meal and gluten meal at the same price, there was little difference in their economy in milk production. In New Hampshire corn meal, shorts, middlings and cottonseed meal were found of about equal value. In the following paragraphs brief notes are given on the individual grains commonly used for feeding dairy cows.

BARLEY AND BREWERS' GRAINS—In German experiments barley meal proved an effective and desirable dairy feed in every respect. In Minnesota ground barley was found equal to ground wheat or corn meal. At the Maine Station barley and peas made a soft butter. The Geneva Station has shown that malt sprouts or brewers' grains may be substituted for oats or peas for milch cows. In Wisconsin malt sprouts proved inferior to cottonseed meal or corn meal. In Connecticut brewers' grains were fed in rations of 13½ pounds with good results, while in Massachusetts they proved to be a good substitute for wheat bran. In New Jersey 4 pounds wet brewers' grains were found equal to 1 pound dry. Neither wet nor dry brewers' grains made good butter in experiments in Scotland.

BEANS—The common sorts of garden and field beans are seldom fed to milch cows in this country. In Scotland horse beans were found to make a good quality of butter. In Massachusetts soy bean meal made more and richer milk and butter of a better color than cottonseed meal. The cottonseed butter was firmer but inferior in texture.

BUCKWHEAT—In a test at the Vermont Station buckwheat middlings made 4 per cent more milk than corn and bran and 3 per cent less than cottonseed or linseed meals. The quality of milk was about the same with all feeds. A subsequent test confirmed these results in general, but showed that milk from buckwheat middlings contained more fat than that from any of the other feeds. The middlings made firmer butter than any other grain ration. Buckwheat middlings are not especially relished alone and should be mixed with other feeds. In New Hampshire ground buckwheat proved valuable for milk production. In New Jersey buckwheat bran free from hulls was found equal to buckwheat middlings, and the Pennsylvania Station found the middlings equal to dried brewers' grains.

CORN AND CORN BY-PRODUCTS—This grain may perhaps best be fed unhusked. The shock corn, however, is commonly run through a feed cutter before feeding to milch cows. After corn has been husked or shelled for some time it becomes very hard and should be ground before feeding. Corn meal is greatly relished by cows, and this fact often leads to excessive feeding. It should be mixed with bran, shorts, linseed meal, cottonseed meal or other nitrogenous grains for dairy feeding.

In New Jersey corn meal gave 9 per cent more milk than whole corn, and 57 per cent of corn fed in the ear was undigested. In Mississippi corn meal was not economically fed with dry hay. At the Pennsylvania Station cerealine was found equal to dried brewers' grains or buckwheat middlings, and the value of corn meal for milk production proved to be 1-5 greater than bran. Danish experiments showed that corn alone was nearly equal to a mixture of barley, oats and corn. According to some experiments in Germany corn was most effective for milk production, followed by wheat bran and cottonseed meal. Gluten meal proved to be an excellent dairy feed in Germany and in Vermont. Atlas gluten meal was more economical, made more milk and sustained the weight of the cows better than corn meal and bran. The butter from gluten meal was slightly inferior in grain to that from corn meal and bran, or that from cottonseed meal or linseed meal. In a second test the butter from gluten meal was best. Buffalo gluten meal was found superior to a ration of cottonseed meal and linseed meal. The Maine Station found that gluten meal could be substituted for cottonseed meal, but that it must be fed in larger quantities. The butter was softer than that from cottonseed meal. In Vermont germ feed had about the same feeding value as a mixture of corn meal and bran. Sugar meal and cream gluten meal were more nutritious and influenced the richness of the milk more decidedly. Both cream and king gluten meals were found to have a greater feeding value than a mixture of corn meal and bran. Chicago maize feed was also superior and corn germ feed equal to the mixture. Atlantic gluten flour fed to excess had little effect on the quantity, and none on the quality of the milk. In Iowa sugar meal produced 8 per cent more milk and 27 per cent more butter than corn and cob meal. It has been found at the Maine, Michigan and New Hampshire Stations that all gluten products containing a large percentage of oil soften the butter. At the Geneva Station wet, acid corn slump, dry slump and dry slump acidified with acetic acid were fed to cows without harm. The milk yield was increased but the quality was adversely affected. In Kansas corn meal was found to increase the milk yield more than bran and oats.

Cottonseed Meal—This is a very effective dairy feed. It should not be fed as the only grain ration, however, and should not be used extensively until some experience has been had on a small scale. At nearly all the stations where it has been tested cottonseed meal was found to raise the melting point of the butter. A little cottonseed meal is recommended when firmer butter is desired. In Texas it made a firm but salvy and light-colored butter, while in Iowa the butter scored as high as that from corn meal, and no bad effects were observed from rations of 2 to 6 pounds per day. In Michigan and New Hampshire butter was badly affected when cottonseed meal was fed to excess. It proved slightly better than corn meal for milk production, and in Germany it was superior to linseed meal for this purpose. In Vermont it made more milk, but also cost more than gluten meal. In Alabama in rations of 3 to 5 pounds per day it diminished the quantity but increased the fat content of milk.

Cottonseed meal added to corn meal gave greater returns than corn meal alone at the Maine Station. In Pennsylvania it produced more milk than bran, but the butter from bran was rated higher. The milk yield was increased by it at the Texas Station. In Mississippi 1 pound of cottonseed meal proved equal to 3 pounds of corn and cob meal for milk production. Cottonseed was found more economical than cottonseed meal, and produced better butter when fed steamed than when fed raw or roasted. In Texas it was found most economical to feed cottonseed in combination with other grains. Rations of 6 pounds of cottonseed meal were found more economical than 7, 8 or 10 pounds. In Pennsylvania cottonseed feed gave a good milk yield, but was too expensive to compete with native grains. In Massachusetts this feed was found about equal to good hay for milk production. At the Tennessee Station rations of 5 to 8 pounds of cottonseed meal and 25 to 35 pounds of cottonseed hulls were fed to cows without any bad effect on the milk or butter. In one test at the Georgia Station cottonseed hulls were found to be less than a maintenance ration, while in another test they proved more economical for roughage than cowpea hay. In Texas the hulls are considered the best roughage to feed with cottonseed meal.

Linseed Meal is an important feed for milch cows on account of its high protein content and its laxative and regulative action. In Colorado it produced a larger percentage of milk fat than any other grain. In Iowa it was found that either linseed meal or ground flaxseed could be safely fed in rations of 8 pounds per day. Linseed meal and bran, substituted for a part of the corn meal ration, increased the yield of milk and butter. In Massachusetts the new and old process linseed meal were found to be of equal value. At the Michigan Station linseed meal had no effect upon the butter. In Pennsylvania it proved equal to cottonseed meal, and in Wisconsin it was found slightly better for producing milk with fat than either wheat bran or corn meal. New process linseed meal was about equal to corn meal, but made a better butter. In Germany flaxseed had little effect in increasing the milk fat, but disturbed the digestion of the cows.

Oats are fed to dairy cows quite extensively. In Scotland they are considered as producing a good quality of butter. In Vermont oat feed was found equal to a mixture of bran and corn meal in equal parts. Quaker oat feed made 2 or 3 per cent less milk than corn meal and bran, but the quality of the milk was the same. In Maine ground oats proved equal to wheat bran for milk production, while in Wisconsin they were found more effective, but also more expensive.

Peas are seldom fed to cows in this country. In Scotland they are much prized as a dairy feed.

Rye Meal was tested at the Pennsylvania Station in a balanced ration. It checked the milk flow somewhat and was inferior to corn meal.

Sorghum Meal, when free from hulls, in experiments in New Jersey, had no effect on the health of the cows and did not influence the taste, color or composition of the milk. It made 7 per cent less milk than corn meal.

Wheat—In Canada ground wheat was found to be a wholesome and effective dairy feed, but was not equal to mixed meal. In Vermont wheat bran proved about equal to buckwheat middlings, barley meal, corn meal or cottonseed meal. In Colorado bran gave larger yields of milk than other grain feeds. In Iowa the milk yield was increased by feeding bran to cows at pasture. In Maine wheat meal proved slightly superior to corn meal. In Massachusetts bran was not very effective when added to a silage ration. In Minnesota ground wheat proved equal to ground barley or corn meal. At the North Carolina Station wheat middlings and bran, half and half, were found more effective than bran alone. In Wisconsin roller bran proved equal to corn meal, nearly equal to linseed meal and more economical than either. In Denmark wheat bran was found superior to mixed barley and oats.

Rations—For obtaining the best results from dairy cows it is desirable to keep the bowels in a loose condition. This matter is easily regulated if the effects of various feeds are kept in mind. The following may be considered loosening feeds: Alfalfa, clover and other legumes, roots, silage, sorghum hay, bran, soy bean meal, linseed meal and gluten meal. The following is a partial list of constipating feeds: Corn fodder, cornstalks, Kafir corn fodder, various grass hays, including timothy, Kafir corn, corn and cottonseed meal. It is also important in dairying to secure a proper firmness in the butter. As a rule corn, Kafir corn and cottonseed meal make hard butter, while linseed meal, soy bean meal and gluten meal have a tendency to soften the butter.

Narrow rations are generally recommended for dairy cows. Narrow rations were found superior to wide rations in experiments at the Hatch, Maine, Massachusetts State, Nebraska, New Hampshire, Pennsylvania, Storrs and Texas Stations. In Vermont no constant differences were noted in the effect of wide and narrow rations, while in New Jersey milk and butter were produced more economically on well-balanced than on irregular rations. The Storrs Station investigated the rations in common use among dairymen in Connecticut and found that the amount of protein could be profitably increased in almost every case. At the Cornell Station a medium ration gave a better yield of milk than a narrow or wide ration. For a discussion of "wide," "narrow" and "balanced" rations see *Feeding Farm Animals.*

Great difference of opinion prevails with regard to the possibility of affecting the amount of fat or other solids in the milk by means of the feed. Experiments along this line have not led to uniform results, but indicate that a specific effect of any feeding stuff on the quality of the milk is either not noticeable or is of short duration. In Massachusetts the quantity and quality were not affected by a change in the grain ration. The New Hampshire Station found that the "quantity is the result of food influence. Quality is the result of the makeup of the animal." At the Cornell Station 4 to 7 pound of palmnut meal per day did not affect the percentage of milk fat. In Massachusetts, New Jersey, Vermont, Germany, Denmark and Scotland the quality of the milk was little or not at all affected by the feed. In experiments at the Iowa Station, however, the quality of the milk was more affected by the feed than the quantity. In Maine the milk yield from a highly nitrogenous ration (cottonseed meal and gluten meal) was greater than from corn meal. The total solids in the milk were 30 per cent to 40 per cent greater, but the relative proportion of the different solids varied independently of the feed. It is concluded, therefore, that it is not possible to produce more butter fat without a corresponding increase of the other milk solids. In Canada it was found that the quantity of the milk could be much influenced by the feed (large quantities of succulent or dry fodders), but the quality was largely determined by the individuality of the cow.

It has also been demonstrated that when there is a lack of fat in the feed the body fat may be changed into milk fat. At the Geneva Station a cow was fed for 95 days on a ration which furnished only 5.7 pounds of digestible fat during the whole period. During this time 62.9 pounds of milk fat were produced, and the cow gained 47 pounds in weight. These results indicate that the protein in a narrow ration may have a stimulative as well as a constructive function.

The Maryland Station maintains that the productive capacity of average dairy cows may be much increased by proper care and better feeding. It is even asserted that improvement of a herd may be secured more quickly by feeding than by breeding. The capacity of a cow may be permanently improved by good systematic feeding for 1 year. The after effects are observed in larger yields of milk during the next year.

The actual size of the ration will vary greatly according to individual cows. Some cows can successfully utilize much more grain and coarse fodder than others. The usual rations of different feeding stuffs are discussed above under the individual feeds. A list of 100 rations for dairy cows was compiled by Woll in Wis. Bul. 38. This can probably be obtained by addressing a request to the station. As an example of a large feeding capacity we may cite the case of a Holstein cow at the Missouri Station which ate as a daily ration 15 pounds bran, 3 pounds linseed meal, 6.65 pounds each of corn meal and ground oats, 42 to 50 pounds of silage and 12 pounds of clover hay. In Pennsylvania it was found that it was not profitable in the case of average cows to increase the ration as long as the milk yield increased. A limit was soon reached beyond which the extra production was obtained at a loss.

Wet vs. Dry Feeds—The Toronto Station found that wetting bran or grains, or "slopping," was an expensive method of feeding. The wet grain passed almost directly into the fourth stomach and was not well masticated. In Iowa, on the other hand, the results were slightly in favor of a wet feed. In Vermont no constant difference was observed in the value for butter or milk from wet and dry feeds.

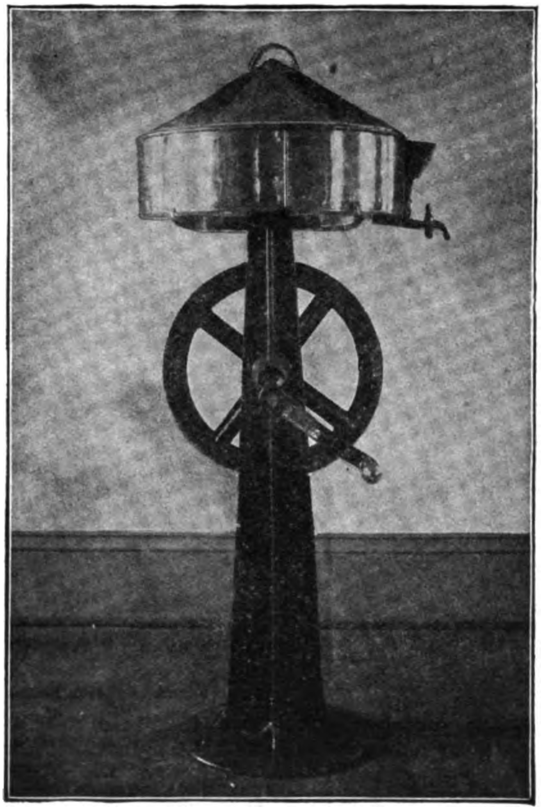

Fig. 357—ORIGINAL BABCOCK MILK TESTER
(U. S. Dept. Agr.)

DAIRYING

In dairying, as conducted at present, the farmer is primarily, or almost exclusively, interested in the production of milk. The technical operations by which butter, cheese, condensed milk and other milk products are manufactured, are chiefly of interest to experts in creameries, cheese factories, etc., to which the farmer delivers his milk. It is only in the rarest instances that the farmer makes his own cheese, and while the butter which is made on the farm is perhaps a larger quantity than that made in creameries, a considerable proportion of farmers and dairymen send their milk to factories or deliver it directly to their customers. In a large percentage of cases, therefore, after the milk has been produced the farmer is directly interested merely in caring for it until it can be delivered to the factory or the patrons of his milk route in good condition. The present discussion will, hence, be confined to a few details concerned with the care of milk and to a brief general account of butter and cheese making.

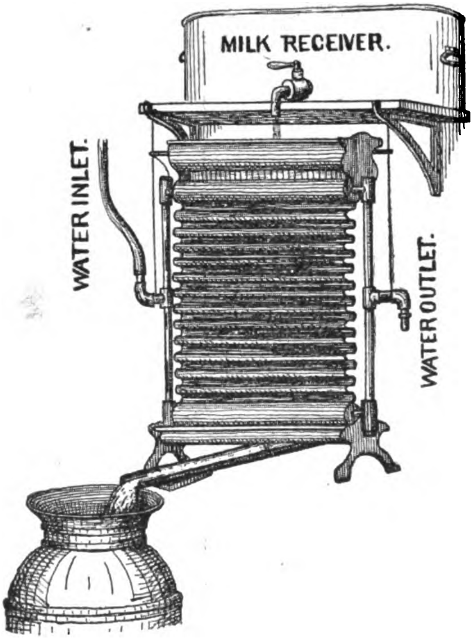
MILK RECEIVER.
WATER INLET.
WATER OUTLET.

Fig. 358—STAR MILK COOLER

Testing Milk—The milk from each cow should be weighed at each milking and a record should be kept so that the productivity of each cow may be known. Unprofitable cows may thus be culled out. From time to time, also, a test should be made of the milk of each cow to determine the percentage of butter fat. The best and simplest apparatus for testing milk is the Babcock tester. (Fig. 357.) For making the test the milk of the cow to be tested should be well stirred so that a fair average sample may be taken. The samples are then mixed with strong sulphuric acid in Babcock test bottles and whirled in the centrifugal testing machine. The heavy parts of the milk are thus forced to the bottom of the bottles and the fat rises to the top, where the percentage may be read from the graduated scale. The principles upon which the Babcock test is based are that strong sulphuric acid dissolves the other solids of the milk, leaving the fat free, and that fat globules, being lighter than the other parts of the mixture, collect nearest the axis of the machine, or in the neck of the bottle, during the centrifugal motion.

Fermentation of Milk—The rapid fermentation of milk is due to the presence of bacteria or other filth in the milk. If milk is intended for the manufacture of butter or cheese the bacteria simply serve to hasten the ripening process. If the milk is to be sold as food, however, it is desirable to keep it sweet as long as possible. Even when every precaution is taken enough bacteria will gain entrance to the milk to produce ripening and souring.

Two hundred or more species of bacteria have been found in milk. The most of them, however, are harmless, except that they cause a rapid souring of the milk. Some produce bitter or otherwise disagreeable flavors, others produce gas, color changes, etc. It should always be remembered, too, that milk may easily become contaminated by the germs of infectious diseases, such as tuberculosis, scarlet fever, diphtheria, typhoid fever, etc. Epidemics of these diseases are often caused by careless milkmen.

Extensive experiments have been made in the use of artificial starters, or pure cultures of bacteria, which have been found to give agreeable flavors to butter or cheese. These methods are easily applied in factories, but are scarcely within the reach of the busy farmer.

Cleanliness—In order to prevent the contamination of milk with bad odors or bacteria the most scrupulous cleanliness is required. No dust should be flying about in the stables at milking time. If the cows are allowed to eat at this time the feed should be sprinkled. It is better not to feed them until after milking. The cows should be clean or thoroughly brushed off, the hands and clothing of the attendants should be clean and no fermenting or decomposing material should be allowed to accumulate in the stables. Careful attention should be given to cleansing and scalding all cans, pails, etc., with which the milk comes into contact. These various precautions have been recommended times without number, but they are by no means universally observed, and as a result the milk sours within a few hours after delivery.

Straining, Cooling, Aerating—Immediately after being drawn from the cows the milk should be strained to remove any coarse filth which may have fallen into it. It may then be aerated by pouring back and forth from one vessel into another, or by the use of one of the many devices designed for this purpose. Aeration is practiced for the purpose of removing animal odors from the milk or odors due to various feeding stuffs. Aeration and cooling may be accomplished at the same time. It is desirable to cool milk down as quickly as possible to 40° to 60° F. A temperature of 40° is better than 60°. The bacteria are thereby prevented from multiplying too rapidly and the milk remains sweet much longer. Where a stream of running water is to be had a Star cooler (Fig. 358) is about as good as any for this purpose.

Pasteurization—This is the process of heating milk to a given temperature for a certain length of time in order to destroy bacteria. The bacteria in milk may be destroyed by boiling, but its flavor and digestibility are thereby affected. The tendency of late, therefore, has been to use the lowest temperature which can be relied upon to kill the dangerous forms of bacteria. At the Michigan Station pasteurization was successfully accomplished by heating the milk to 155° and keeping it at that temperature for 20 minutes. Later experiments at the Wisconsin Station showed that when milk was maintained at 140° F. for 15 to 20 minutes 99 per cent of the bacteria were killed, and the milk kept for 6 days. The usual method of pasteurizing milk consists in placing it in vessels surrounded by hot water, as shown in Fig. 359.

Composition of Milk—Where milk is produced for the manufacture of butter the percentage of butter fat is an important matter. The average percentage composition of milk is about as follows: Water 87 per cent, fat 4 per cent, casein 3.4 per cent, milk sugar 4.9 per cent, and ash .7 per cent. In making butter, fat is the only solid which is removed from the milk, while in the manufacture of cheese both the casein and fat are removed.

Creaming of Milk—There are 3 general methods in vogue among farmers for separating the cream from milk, viz: Setting in shallow pans, setting in deep cans with cooling devices, and the use of separators. The third method is the best, for various reasons which will be mentioned below. It is best to run the milk through the separator or set it as soon as possible after milking. There is no great loss in butter fat, however, if these operations are delayed for 3 or 4 hours. Milk should be cooled before setting, otherwise some fat is lost. This matter, however, is less important in the North than in the South.

With shallow setting in pans 2 or 3 inches deep the best results cannot be obtained if the milk is allowed to become warmer than 60° F. The milk should be set in a cool, dry, well-ventilated room free from bad odors. The cream should be removed as soon as the milk at the bottom of the pans has thickened.

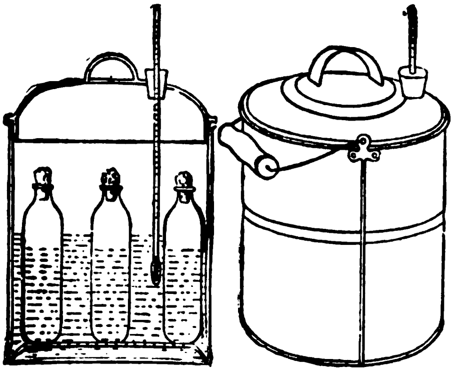

Fig. 359—SIMPLE PASTEURIZING APPARATUS

If the milk is set in deep "shotgun," or Cooley, cans, these should at once be placed in ice water or cold running water. For cooling milk in such cans spring houses are quite satisfactory. The water around the cans should be between 40° and 55° F. At the Cornell Station it was found that 24 hours was a long enough period for shallow setting. Some fat was lost when the pans were skimmed after 12 hours. At a temperature of 70° F. the cream was found to rise faster when the milk was set 3 inches deep than when it was set 6 or 9 inches deep.

The use of a separator is a better method for securing the cream than any setting method. If the separator is used no ice or extensive cooling devices for the milk are required; the bacteria have no time to develop and multiply; more cream is obtained from the same quantity of milk, and the skimmilk may be fed to the calves and pigs in a sweet and wholesome condition. Sweet skimmilk is incomparably better for feeding calves than sour skimmilk. (See *Calves* under *Cattle.*)

A long series of observations and experiments in Wisconsin indicates that by the ordinary methods of setting milk about 20 per cent of the total butter product is lost. In other words, by setting the milk of cows which yield enough butter fat to make 300 pounds of butter per year 60 pounds of butter is lost. This amount at 20 cents per pound makes $12 per cow, or $120 for a herd of 10 cows. The latter sum is sufficient to pay for a good separator.

Butter Making—Cream from shallow setting is ripe, or nearly so, when removed. That obtained from cool, deep setting may be sweet when skimmed off, and must therefore be allowed to stand for 24 to 48 hours to ripen. Cream as it comes from the separator is warm and sweet and should be cooled immediately and allowed to ripen. It is impossible to describe the exact stage of ripening at which cream should be churned. Acid tests have been devised to determine when the right degree of acidity has been reached. As a rule, however, this method must be learned by experience.

It is usually recommended that cream be at least 58° to 62° F. when placed in the churn. This is an important matter, and the farmer should provide himself with a good dairy thermometer and not merely guess at the temperature. A revolving churn is best. It should be filled 1-3 to ½ full with cream and should be revolved at a rate of 50 to 60 revolutions per minute. One can recognize by the sound when the cream begins to break, and churning should cease when the butter granules are somewhat smaller than wheat kernels. The buttermilk should then be drawn off and the butter should be washed twice with cold water, revolving the churn a few times for each washing. Do not wash the butter any more, as its flavor and aroma are rapidly removed by the water. The details of working, salting and coloring butter cannot be given in this short account. The usual rule is to allow 1 ounce of salt to each pound of butter, or about 8 pounds of salt to each 100 pounds of butter fat. The kind of salt to be used will be determined by the market requirements in each locality. In Wisconsin it was found that a coarse salt increases the weight of the butter rather more than a fine salt.

Cheese—Despite a popular belief to the contrary, experiments show that there is no such thing as a "cheese cow." In general, cows which are good for butter production are also good for cheese. If, however, milk contains more than 4 per cent of fat it is considered more profitable to make it into butter than cheese.

A few notes may be given in this connection on the manufacture of cheddar cheese. Milk for cheese must be sweet when received, or should not contain more than a trace of acid. It is then heated and ripened, using a starter, if necessary, to prevent the too great development of harmful bacteria and consequent spoiling of the flavor of the cheese. Sour milk of good quality or lactic ferment may be used as a starter. After the milk is ripened the coloring matter is added, the milk is set at a temperature of 86° F. and the rennet is evenly distributed in the vat, after being diluted with water. When the curd breaks readily it is cut into small cubes by means of a curd knife. It is then heated and stirred until the proper amount of acid is developed, when the whey is drawn and the curds washed and milled. Attention should be given to pressing out any excess of gas. The curd is then salted, pressed, greased and stored for ripening. In making cheddar cheese about 2½ pounds of salt are used for each 100 pounds of curd.

SILAGE

Green forage preserved in air-tight buildings known as silos. Silage was first prepared in the United States in 1875 by Manly Miles of Michigan. It is now extensively used throughout the country, especially in the Northern dairy sections, as a succulent food for cattle and sheep and to a lesser extent for other animals. The advantages claimed for silos and silage are briefly as follows: (1) Succulent palatable rations may be had for stock during the entire year, thus keeping the animals in good physical condition and maintaining the milk flow of dairy cows and breeding ewes. (2) A larger percentage of the food harvested can be preserved by ensiling than by curing as hay or fodder. (3) Three or more times the quantity of food can be preserved in the same space. (4) It costs less to preserve forage in the silo than to cure it by any other method now known. (5) More stock can be kept on the same area of land where silage is made than where the crops are all cured in hay or fodder. (6) Silage can be made in catchy weather when hay would be spoiled. (7) Crops unfit for hay making or cured fodder, such as weeds, sunflowers, horse beans, etc., can be changed into palatable fodder by preserving in the silo. This may be an advantage when the regular crops fail.

Crops for Silage—All crops used for forage may be preserved as silage. The crops usually grown for silage are corn, clover, millet, the small grains, peas, sorghum, alfalfa, cowpeas, soy beans, etc. Corn is the chief crop grown for silage. It is the kind usually understood when silage is mentioned. More silage is made from corn than from all other crops put together.

CORN—Experiments at a number of stations indicate that corn for silage should not be broadcasted but sown either in drills about 3½ feet apart and the kernels dropped 6 to 9 inches distant in the row, or in hills 3½ feet apart each way, placing 4 to 5 kernels in each hill. The crop is richest in feeding value if cut and put into the silo when the kernels begin to glaze or when denting is well established. It is usual to cut the corn and draw directly to the silo. Better results in feeding have been obtained at the Wisconsin and Vermont Stations by ensiling and feeding the grain with the stalks than by harvesting and feeding the grain separately. Other experiments show that it is more economical to ensile corn, ears and all, than to ensile only the stalks and husk out the corn.

Corn packs better, keeps better, is more easily handled, and is more nearly all consumed if it is cut up into small lengths before putting in the silo. About half-inch lengths are preferable and recent work appears to show that better silage will be obtained if the stalks are shredded as well. Corn can be ensiled whole, but the labor of handling makes it an unsatisfactory method of preserving corn. If the whole stalks are put into the silo they should be closely packed in layers. The corners should be packed with stalks bent to fit them. In filling the silo with cut corn great care should be taken to have the corners and the silage along the walls well tramped, not only while the silo is being filled, but every 2 or 3 days thereafter for 8 or 10 days.

The silo may be filled as rapidly as the corn can be cut or the filling may extend over quite a long period without affecting the quality of the silage. Two or 3 feet of silage may be put in one day and this allowed to heat and settle a day or two and 2 or 3 feet more put in. When the silo is full the top may be thoroughly wet down with about a 10-quart pailful of water to each square foot of surface. This causes a few inches of the top to rot thoroughly and form a kind of covering impervious to air which protects the silage underneath. No other covering or weighting is necessary. If the water is not put on about 8 to 9 inches of the top will rot.

Corn loses in feeding value when put in the silo but not so much as when cured outdoors. The average loss in 4 years at the Wisconsin Station when corn was ensiled was 15.6 per cent dry matter and 16.8 per cent of the protein in the corn. Corn fodder, cured according to the usual methods, lost during the same period 23.8 per cent dry matter and 24.3 per cent protein. Considerably larger losses are reported for fodder cured outdoors by a number of other stations. The necessary losses in a well-conducted silo are considerably less than those noted above. Recent work at the Wisconsin Station shows that they need not exceed 4 to 8 per cent of dry matter.

Relative to varieties of corn most suited for silage in any locality, those surest to mature before frost should be chosen. On the northern borders of the corn belt the flint corns and some of the earliest dents should be grown. Farther south the varieties producing the largest amount of food per acre, like Burrill, Leaming, Whitman and Mosby Prolific, should be grown. For other varieties see under *Corn*. It costs from 60 to 75 cents per ton to put corn in the silo.

CLOVER—Common red clover is the kind usually put into the silo, though Crimson clover has been recommended by the New Jersey Station and Mammoth clover is often used. Clover silage is greatly relished by horses, cattle and sheep and pound for pound is richer than corn silage. It does not produce as much food per acre, however, as corn. Clover may be put into the silo whole, but it packs much better and is more easily handled if run through the cutter and cut into half-inch lengths. If clover is put into the silo without cutting considerable cut corn silage should be run on top of it to weight it down. Even more care should be taken to tramp the corners and sides of the silo than with corn. It is in the corners that the greatest losses occur in ensiling unless they are packed so tightly as to exclude all air.

Clover should be cut for silage when in full bloom and when the dew is off. It should be drawn directly to the silo before it wilts. As a result of 2 years' tests at the Michigan Station, Smith found that while ensiled clover kept well and was greatly relished by stock, it was cheaper to cure it for hay than put it in the silo. It is no doubt true, however, that a good crop of clover could be secured for the silo when catchy weather would make hay making impossible. It must also be remembered that when clover is put in the silo all the leaves and more tender parts are preserved, while in field curing 25 and often 50 per cent of this most valuable portion of the plant is dried up, broken off and lost.

MISCELLANEOUS—Sorghum has been ensiled at some of the stations but is not so satisfactory as corn. In some localities it yields heavier than corn and remains green later in the fall. It is not so greedily eaten by stock as corn silage. Sorghum silage is made in the same manner as corn silage.

Good results have been reported in the use of millet as silage by the Michigan Station. Alfalfa takes the place of clover as a silage crop in the West and is ensiled in the same manner as clover. Cowpeas constitute the chief leguminous forage crop of the South for silage. Robertson's silage, consisting of a mixture of corn, sunflower heads and horse beans, in the proportion of 1 acre corn, ½ acre horse beans and ¼ acre sunflowers, has given satisfaction in some Canadian feeding experiments and reported on favorably by some stations in the United States. Beet pulp obtained as a by-product of sugar beet factories can be readily preserved by packing it in the silo.

Fermentation of Silage—When green forage is first put into the silo it undergoes a more or less rapid fermentation and consequent rise in temperature. It has been commonly supposed that this fermentation was due to the action of bacteria, but recent experiments at the Wisconsin Station indicate that the normal changes in silage are due to physiological processes in the living plant cells themselves and not to bacteria. Bacteria and molds function only in a detrimental way when air finds access to the silage.

Use of Silage—Good silage is fully equal to roots in feeding value and is much cheaper. Feeding may commence as soon as the silo is filled. From 1½ to 2 inches of the silage should be fed from the surface each day in order to prevent losses from spoiling. A desirable feature about silage is that it may stay in the silo 2 or more years without loss in feeding value. Many extravagant claims were made for the feeding value of silage when it first came into use. Station experiments show that silage has no greater feeding value than cured forage from which it is made. Experience does show, however, that it is usually the cheapest method for putting up forage and it furnishes a succulent and very palatable ration for stock at a time when such foods are most needed.

Silage is pre-eminently adapted for dairy cows. It promotes and maintains the milk flow and if fed just after milking does not taint the milk. The silo is more in favor with dairymen than with any other class of farmers. From 30 to 35 pounds of silage per day along with hay and grain is considered the most satisfactory ration for dairy cows. A number of feeding experiments with silage for dairy cows are reported under *Dairy Farming.*

Beef cattle have not been so extensively fed as dairy cows; but a number of experiments are reported on this subject. (See under *Cattle.*) The Kansas Station points out in this connection that silage should not be fed to breeding bulls. At that station bulls fed on silage seemed to lose their virility and became slow and uncertain breeders. They recovered when again fed on dry fodder.

Sheep do well on silage. About 4 pounds of silage is considered equal to 1 pound of good hay for sheep. Clover silage proved especially valuable for breeding ewes at the Wisconsin Station. Silage should not constitute the sole ration but be fed with grain and hay. About 2 pounds per head per day is sufficient for sheep and in no case should it exceed 5 or 6 pounds. For experiments with silage for sheep see under *Sheep*.

A number of attempts have been made to feed silage to hogs but without success. They do not appear to relish it or thrive on it. (See *Swine*.)

Silage has been found a good feed for horses when fed not to exceed 20 pounds a day. It should be fed in small amounts at first and preferably with cut hay.

Literature—The following excellent bulletins on silos and silage can probably be obtained upon application: U. S. Dept. Agr. Farmers' Bul. 32; Wis. Expt. Sta. Bul. 83; Ind. Expt. Sta. Bul. 40; Ore. Expt. Sta. Bul. 67. See also "Book on Silage," by F. W. Woll; "Soiling, Ensilage and Silage," by Manly Miles; "Soiling Crops and the Silo," by Thomas Shaw.

SILO

A building for the preservation of green fodder. (See *Silage*.) The first silos were simply pits dug in the ground. These were filled with green forage, then heavily weighted and covered over with earth to keep out the air. They preserved the silage fairly well but were very inconvenient. Since about 1875 silos of stone, brick and wood have come into use. Those built of wood are least durable but the first cost is considerably less than where brick, stone or cement is used and they are equally efficient in preserving the silage. More wood silos are built at the present time than of any other kind.

Depth of silo in feet	Inside diameter of silo in feet, and capacity in tons											
	15	16	17	18	19	20	21	22	23	24	25	26
	Tns	Tns	Tns	Tns	Tns	Tns	Tns	Tns	Tns	Tns	Tns	Tns
20	59	67	76	85	94	105	115	127	138	150	163	177
21	63	72	81	91	101	112	123	135	148	161	175	189
22	67	77	86	97	108	120	132	145	158	172	187	202
23	72	82	92	103	115	127	141	154	169	184	199	216
24	76	87	98	110	122	135	149	164	179	195	211	229
25	81	92	104	116	129	143	158	174	190	206	224	242
26	85	97	110	123	137	152	167	184	201	219	237	257
27	90	103	116	130	145	160	177	194	212	231	251	271
28	95	108	122	137	152	169	186	205	223	243	264	285
29	100	114	128	144	160	178	196	215	235	256	278	300
30	105	119	135	151	168	187	206	226	247	269	292	315
31	110	125	141	158	176	195	216	236	258	282	305	330
32	115	130	148	166	185	205	226	247	270	295	320	346

The essentials of a good silo are that it be air tight, cheap, simple of construction and durable. Some of the principles to be observed in its construction are: (1) That it be made deep in order that the silage may pack down solidly together and exclude the air. Wherever possible it should have a depth of not less than 24 feet. The better silos are usually built 30 feet deep. Very satisfactory silos, however, may be built with depths of only 20 feet or even less. (2) The walls should be vertical and perfectly smooth so that the silage may settle evenly on all sides. There should be as few corners as possible, since the greatest losses from spoiling occur in the corners. (3) Square wooden silos should have the corners boarded across and the inside sheathing should run perpendicular to the bottom. (4) The inside walls of stone, brick or cement silos should have a final dressing of Portland cement. (5) The silo should be located where it will be most convenient to feed from.

The size of the silo to build may be determined in any particular case from the following data: A cubic foot of well-packed silage will weigh on the average between 35 and 40 pounds, and this is about the amount that should be fed daily to a dairy cow weighing 1000 pounds. If it is necessary to feed cows for 6 months, or 180 days, during the winter 1 cow will consume 180 cubic feet, or about 3½ tons of silage. A herd of 20 cows would consume 70 tons during the same period. Since, however, there is always some spoiled silage and waste, a safer estimate for the requirements of a herd of this size would be 80 to 90 tons. An acre of good clover or corn will yield 10 to 15 tons of silage.

Another factor that must be considered in feeding out silage is the depth of silage removed each day. Experience has shown that after feeding from the silo has begun a depth of about 2 inches in winter and 3 inches in summer should be removed from the whole surface exposed each day to prevent loss from spoiling. One cow, therefore, requires a surface area of silage each day of about 5 square feet, and a herd of 20 cows 100 square feet. This would call for a silo 10 feet square or a round silo a little more than 11 feet in diameter.

The number of tons of silage that a square or rectangular silo will hold may be determined roughly by multiplying together the length, width and depth of the silo in feet and dividing by 50, the approximate number of cubic feet in a ton of silage. Since it is a little more difficult to calculate the capacity of round silos, the table on Page 377, adapted from King, is given.

Silos should be constructed with a capacity of 1-3 to ½ greater than indicated in the table to allow for settling and waste. A silo rapidly filled and not refilled again will settle nearly one-half.

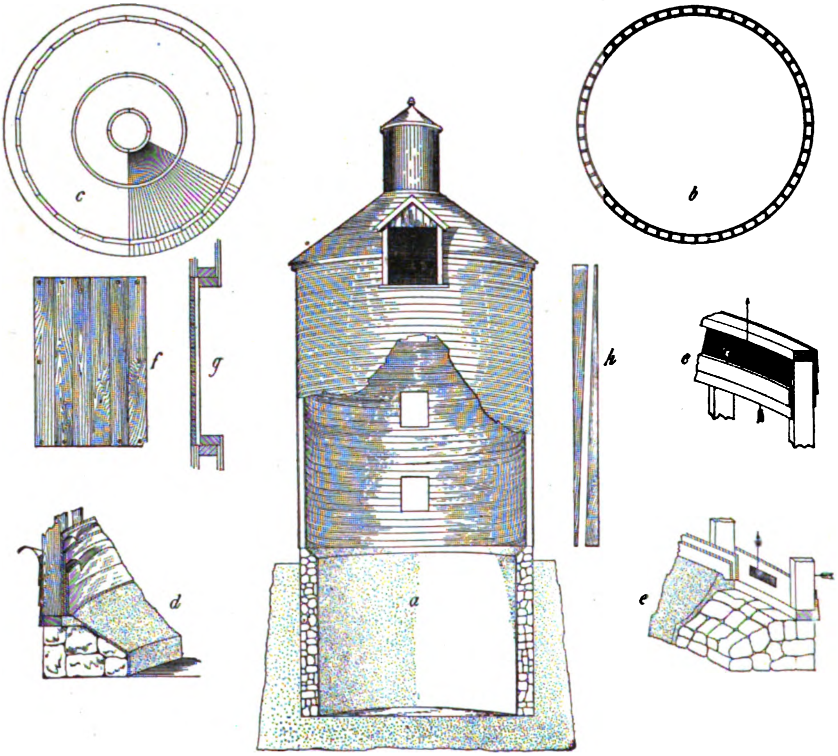

Fig. 360—THE WISCONSIN ROUND SILO

a, interior view; *b*, cross section; *c*, roof from below; *d*, top of foundation wall, sill, studs and 2 layers of sheeting with tarred paper between; *e*, *e*, method of ventilating wall; *f*, door; *g*, door fitted into opening; *h*, boards for roof

The most popular forms of silos are round, square and rectangular. The square and rectangular silos are best adapted for use in barns already built. They fit into the bays without waste of space and part of the framework of the barn may be used in their construction. Out of doors more round silos are built than of any other sort.

The advantages of the round silo are the greatest holding capacity for a given amount of building material, greatest rigidity and strength and no corners for spoiled silage. For a given capacity they are the cheapest form of silo that can be built. The round silo was originated by King of Wisconsin Station, and the following directions for constructing a round silo are based on his description.

Round Silo.—In building a substantial round wooden silo a circular foundation of stone or brick 18 to 24 inches thick and extending below the frost line should first be put in. The wall should extend above ground at least a foot to preserve the woodwork from decay. The bottom of the silo may be of cement or hard packed clay. The sills should be made of 2x4's cut to 2-foot lengths, properly beveled, toe-nailed together and bedded in mortar or cement on the outer edge of the foundation wall. The inner edge of the foundation wall should slope smoothly downward so that the silage may settle evenly. Or it may be built up even and the sills rest on this edge, the outer edge being built sloping and shingled to prevent water from getting into the wall. The studding should be 2x4's set 1 foot apart from center to center and toe-nailed to the sill. The studs are first set in the angles of the sill and plumbed and stayed from a post in the center. As soon as 5 or 6 studs are set up they are stayed and plumbed from side to side by tacking a strip of ½-inch sheeting to them on the outside as high up as a man can reach. After the studs have been set at the angles the intervening ones may be put in and plumbed and stayed to the rib holding the others. When studding longer than 20 feet are required short lengths may be lapped 1 foot and spiked together before setting in place. On the side of the silo where the doors are to be built for taking out the silage the studding on either side of the door should be set double and as far apart as the door is to be wide. A stud is set in the center between these and the doors cut out afterward. The form of the door is shown in *f* and *g*, Fig. 360. The outside of the silo is covered with a single layer of beveled siding rabbeted on the inside of the thick edge to fit the thin edge of the board below. For lining 2 layers of ½-inch sheeting with a layer of acid and waterproof paper between is used. Both linings are put on horizontal and made to break joints at their centers. Two 8-penny nails are used in each board at each stud with the first lining and 2 10-penny nails at each stud with the second lining. The paper should lap about 2 inches and the edges be tacked down with carpet tacks. Ventilation between the walls is secured by openings through the siding at the bottom of the silo and of the inside lining at the top. The plate is made in the same manner as the sill. With silos less than 15 feet in diameter no rafters are used, but instead a circle made of 2-inch stuff cut in sections in the form of a circle and 2 layers spiked together, breaking joints. The roof boards are made by ripping 8-inch common boards diagonally so as to make 2 boards 6¾ inches wide at one end and 1¼ inches at the other. These are nailed to the plate and the circle. A cupola is put on for ventilation. The filling door is made at least 3 feet wide. The inside of the silo is neither painted nor tarred, as it is believed such treatment favors decay of the silo by preventing the walls from drying out rapidly after the silage is removed. The building material necessary for the construction of a silo similar to the above, 30 feet deep, 14 feet in diameter and having a capacity of 90 tons of silage, is given by Plumb as follows:

	Cost[*]
Brick for foundation, 1 foot thick and 3 feet deep, 3375	
Studs, 2x4, 16 feet long, 50 pieces	
Studs, 2x4, 14 feet long, 50 pieces	
Flooring for doors, 32 feet	
Sheeting, half-inch (resawed from 2x6 plank, 16 feet long, sawed 3 times), dressed on 1 side to uniform thickness for inside lining of 2 layers, 3000 feet, and for weatherboarding for the outside, 1500 feet; in all 4500 feet	
Tar building paper, water and acid proof, 200 yards	
Nails: 8-penny, 200 pounds; spikes, 20 pounds; shingle nails, 12 pounds	
Rafters, 2x4, 10 feet long, for ridge roof, 22 pieces	
Sheeting for roof, 16-foot boards, 350 feet	
Shingles, 3000	
Dormer window for filling through	
Paint for 2 coats, 7 gallons	
Cement for cementing bottom, 2 barrels	
Total cost	

Rectangular Silos—In building a rectangular silo the sills should be made of 2 2x10-inch plank spiked together and framed so as to overlap each other at the corners. They should be bolted to the stone foundation walls by means of upright bolts cemented in the walls while they are being built. One bolt should be at each corner and from 3 to 6 feet apart along the sides. A 2x4 stud is spiked along the outer edge of the sill for the studs to be blocked against. The studs should be 2x10-inch stuff and spaced 18 inches apart. With silos more than 20 feet deep 2x12-inch sills and studs should be used. Plates of the same size should be spiked to the top of the studs and tied across to opposite studs either by cables or joists to keep the walls from spreading. The inside lining may consist simply of tarred paper tacked to the studs and a single layer of inch boards, preferably 6 inches wide, nailed on to the studs horizontally. If 2 layers of boards are used the tarred paper should be placed between them and the inside layer be put on perpendicular. Plumb gives the following estimate of material required for a silo 15 feet square, 20 feet deep and having a capacity of 94 tons; the estimate is made for a silo built within a barn and not sided on the outside:

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[*] **Cost is to be ascertained by filling in the prices for building material in the different localities.**

	Cost*
Cement, Portland, 3 barrels......	
Foundation, 3x1½ feet, by 66 feet	
Sills, 2x12, and 18 feet long, 8 (144 linear feet)	
Studs, pine, 2x10, 82 pieces (half 8 and half 12 feet long)........	
Lining, No. 2 fencing, 1400 feet..	
Lining, No. 1 fencing, 1400 feet..	
Top plate, 2x8, 16 feet long, 4 (66 linear feet)	
Tarred paper, 1400 feet surface....	
Nails, 100 pounds................	
Total cost	

Stave Silos—The stave silo is easily constructed, cheap and usually very efficient in preserving the silage without loss. For these reasons it is growing in popularity, though it has some defects and requires more attention to keep it from getting out of shape than other forms of silo. One form of this silo has been fully described by Clinton in N. Y. Cornell Expt. Sta. Bul. 167; this account is adapted from his description.

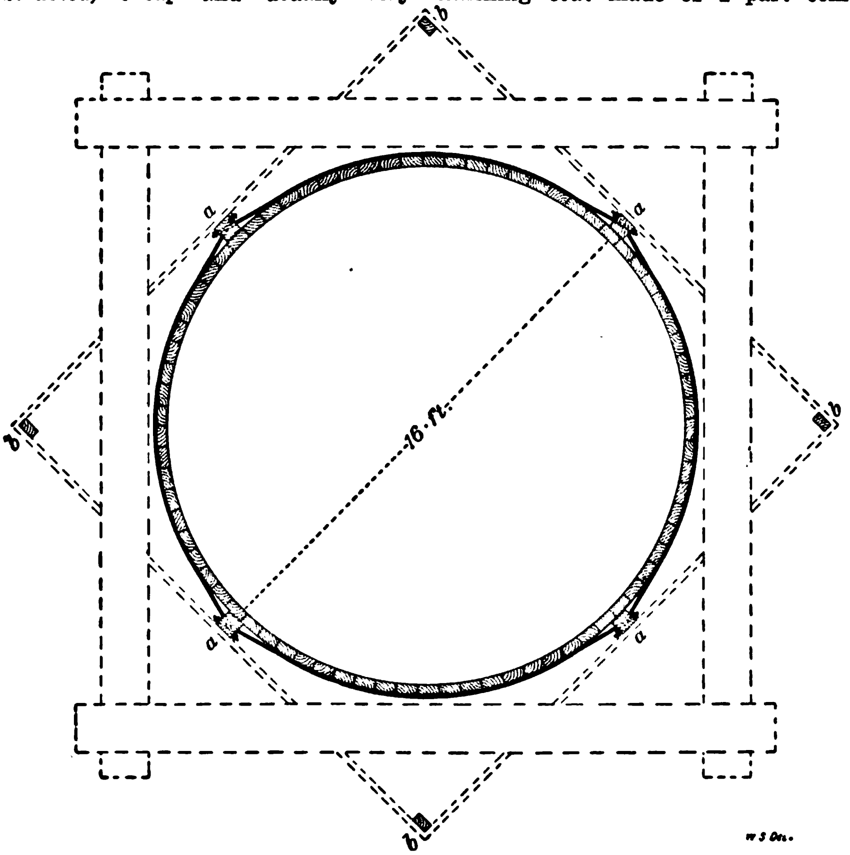

Fig. 361—CROSS SECTION OF STAVE SILO
The dotted lines show how scaffolding may be put up

The foundation should be made to the depth of the surface soil and pounded full of stones, placing the large ones on the bottom and working the smaller ones in above. The pounding should be thoroughly done, otherwise the foundation is likely to crack. A thin cement made of 1 part Portland or Rosendale cement and 4 parts sharp sand is poured over the entire stonework. The mortar should be so thin that it will run down into the interstices between the stones. When this coat has thoroughly set a finishing coat made of 1 part cement and 3 parts sharp sand should be put on and worked down with a trowel. The circle on which the staves are to set may be marked out by driving a spike in the center of the silo to serve as a pivot. A string ½ the diameter of the silo is then attached to the spike and a pencil or pointed instrument attached to the free end with which the circle is struck.

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*Cost to be ascertained by filling in prices of building material in each neighborhood.

Hemlock staves are considered one of the cheapest satisfactory materials for the silo. When the silo is to have a diameter of 12 feet or less the staves should be of either 2x4-inch material unbeveled on the edges and neither tongued nor grooved, or of 2x6-inch material beveled slightly on the edges to make the staves conform to the circular shape of the silo. When the diameter is more than 12 feet 2x6-inch material neither beveled nor tongued and grooved should be used. The inside face of the staves should be surfaced to facilitate the settling of the silage.

One method of setting up the silo is shown in Fig. 361.

The posts *a,* should be of 6x6 material and run the entire length of the silo. These should be first set up vertically and stayed securely in place. The scaffolding may be constructed by setting up 2x4 scantling in the positions shown at *b.* Boards nailed from these 2x4 scantling and to the 6x6 posts will form a rigid framework across which the planks for the scaffold platform may be laid. Before the scaffolding is all in place the staves should be stood up within the inclosure; otherwise difficulty will be experienced in getting them into position. The first stave set up should be made plumb and should be toe-nailed at the top to one of the 6x6 posts originally set. If one man works at the top of the staves and one at the bottom with another man to assist in raising them in position they may be set up very rapidly. "Immediately a stave is set in place it should be toe-nailed at the top to the preceding stave set. It has been found that the work of setting up and preserving the circular outline may be materially aided by the use of old barrel staves as shown in Fig. 362. For a silo 12 feet in diameter the curve in the stave of the sugar barrel is best adapted; for a 16-foot silo the flour barrel stave is best, and for a silo 20 feet or more in diameter the stave of the cement barrel is best. . . . If when the silo staves are put in place they are toe-nailed securely to the ones previously set; if they are fastened firmly to the permanent upright posts (*a*); if the barrel staves are used as directed above, the silo will have sufficient rigidity to stand until the hoops are put in place. However, if it becomes necessary for any reason to delay for any considerable time the putting on of the hoops, boards should be nailed across the top of the silo."

When it is found impossible to secure staves of the full length desired, a joint or splice must be made.

"For a silo 30 feet deep, staves 20 feet in length may be used. A part of these should be used at their full length and part should be sawed through the middle, thus making staves of 20 and 10 feet length. In setting them up the ends which meet at the splice should be squared and toe-nailed securely together. They should alternate so that first a long stave is at the bottom, then a short one, thus breaking joints at 10 feet and 20 feet from the base."

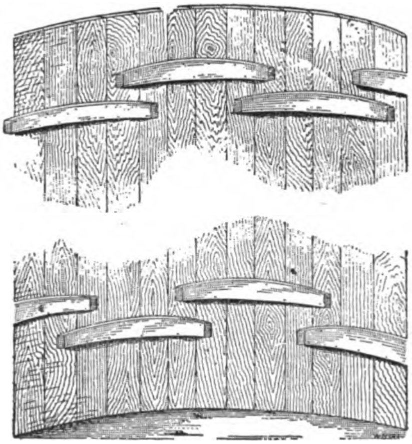


Fig. 362—BARREL STAVES USED TO PRESERVE CIRCULAR OUTLINE OF STAVE SILOS (After Clinton)

For the hoops ⅝-inch round iron or steel rods are recommended, although cheaper substitutes like wire fencing have been found very satisfactory. Each hoop should be in 3 sections for a silo 12 feet in diameter; in 4 sections for a silo 16 or more feet in diameter.

"If the method of construction shown in Fig. 361 is followed, then the hoops will need to be in 4 sections each, the ends being passed through the upright 6x6 posts and secured by heavy washers and nuts. . . . The bottom hoop should be about 6 inches from the base of the silo; the second hoop should be not more than 2 feet from the first; the third hoop 2½ feet from the second, the distance between hoops being increased by ½ foot until they are 3½ feet apart, which distance should be maintained except for the hoops at the top of the silo, which may be 4 feet apart. . . . To hold both the hoops and the staves in place during the summer when the silo is empty, staples should be driven over the hoops into the staves.

"The hoops should be drawn fairly tight before the silo is filled, but not perfectly tight. They must be tight enough to close up the space between the staves, thus preventing any foreign matter from getting into the cracks which would prevent the staves from closing up as they swell, thus allowing air to enter. . . . The hoops should be watched very closely for a few days after the silo is filled. If the strain becomes quite intense, the nuts should be slightly loosened. If during the summer when the silo is empty and the staves thoroughly dry the hoops are tightened so that the staves are drawn closely together, when the silo is filled and the wood absorbs moisture and begins to swell, the hoops must be eased somewhat to allow for the expansion."

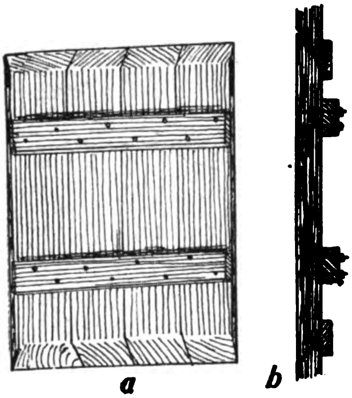


Fig. 363—APPEARANCE OF DOOR OF STAVE SILO AFTER BEING SAWED OUT, AND SIDE VIEW OF DOOR IN PLACE. THE CLEATS ARE ON THE OUTSIDE OF THE DOOR

The doors for the silo should be located on the side of the silo most convenient for feeding.

"The lower door should be between the second and third hoops at the bottom and other doors will usually be needed in every second space between there and the top, except that no door will be needed in the top space, as the silage when settled will be sufficiently low to enable it to be taken out at the door in the space below. Plans should be made for the doors at the time the staves are set. When the place is reached where it is desired to have the doors, a saw should be started in the edge of the stave at the points where the top and bottom of the doors are to come. The saw should be inserted so that the door can be sawed out on a bevel, making the opening larger on the inside of the silo. (See Fig. 363.) This will enable the door to be removed and put in place only from the inside, and when set in place and pressed down with silage the harder the pressure the tighter will the door fit. . . . After the silo is set up and the hoops have been put on and tightened, the cutting out of the doors may be completed. . . . Before cutting out the doors cleats 2 inches by 3 inches, and in length equal to the width of the door, should be made which will conform to the circular shape of the silo. One of these cleats should be securely bolted to the top and one to the bottom of where the door is to be cut. After the bolting the door may be sawed out, and it is then ready for use. When set in place at time of filling the silo a piece of tarred paper inserted at the top and bottom will fill the opening made by the saw and prevent the entrance of any air around the door."

When this form of silo is constructed out of doors some form of roof will be necessary. It should be wide enough to thoroughly protect the sides of the silo from the elements. A serviceable roof is shown in Fig. 364. At the present time a number of manufacturers are placing stave silos on the market ready for setting up.

For a further discussion of silo building consult "A Book on Silage," by F. W. Woll; "Soiling Crops and the Silo," by T. Shaw; "Silos and Silage" (U. S. Dept. Agr. Farmers' Bul. 32, revised), by C. S. Plumb; "Silage and the Construction of Modern Silos" (Wis. Expt. Sta. Bul. 83), by F. H. King; "The Construction of the Stave Silo" (Cornell Expt. Sta. Bul. 167), by L. A. Clinton; "The Modern Silo" (Ind. Expt. Sta. Bul. 91), by C. S. Plumb; "The Silo and Silage" (Ore. Expt. Sta. Bul. 67), by J. Withycombe; and "Building Silos" (Mich. Expt. Sta. Special Bul. 6), by C. D. Smith.

SOILING

Soiling is the practice of raising various forage crops to be cut green and to be fed in this condition to animals.

By a system of soiling instead of pasturing, an increase in the productive acreage of the farm is secured, a much greater amount of forage is produced on a given area of land than by pasturing, less land and less grain are required, the land is maintained in a higher state of cultivation and fertility, and the manure is preserved.

As the price of farming land increases, especially in the neighborhood of cities, it becomes unprofitable to hold large areas of arable land for pasture. Several experiment stations have tested the system of soiling and report favorably upon it both as the exclusive method of summer feeding and for supplementing pasture late in the season when pasturage is short and dry. No extra expense is incurred in introducing the system upon a farm and no machinery other than that ordinarily possessed by farmers is required.

In order to have green crops for soiling during the whole season from early summer till fall, it is necessary to adopt a suitable rotation of soiling crops. With the exception of corn and sorghum, soiling crops do not remain at their best for more than about 10 days. It may, therefore, be desirable to sow a portion of each plot of land at weekly intervals. Wheat and rye may be sown in the fall and will be ready to feed during May and June of the following season. In the spring barley may be sown as early as possible, followed by 4 or 5 sowings of oats and peas at weekly intervals. These will serve as soiling crops for July. At the time the last sowing of oats and peas is made corn or corn and sorghum may be sown and will be ready for use in August and September. The ground occupied by the oats and peas will be free by the end of June and may then be sown to millet and barley for use in the latter part of September and first part of October.

At the New Jersey Station it was found that by a proper system of rotation a continuous supply of green forage could be obtained from May 1 to November 1, and that 7 acres of land would produce enough coarse fodder for 25 cows. According to this system rye and crimson clover are sown together in September to be cut the next year, May 1-10. Oats and peas are sown on this acre May 10 to be cut July 1-10. Soy beans are sown July 10 to be cut September 1-10. On the second acre there is a rotation of wheat, cowpeas and Japanese millet, on the third crimson clover and corn, on the fourth mixed grasses and corn, on the fifth oats and peas, Japanese millet, barley and peas, on the sixth oats and peas, cowpeas and barley and peas, and on the seventh corn alone. The various crops are sown at such times and in such rotation as to furnish a continuous supply of forage. This scheme is mentioned simply as one example of a successful system of rotation for soiling crops

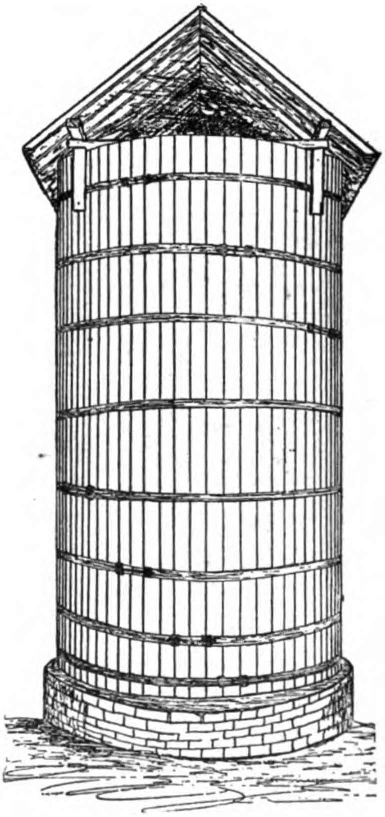


Fig. 364—ROOF FOR STAVE SILO

Of the various crops which were tested at the New Jersey Stations in soiling experiments, alfalfa, rye, corn, crimson clover, oats and peas, and the millets gave the most profitable returns, while red clover, cowpeas, soy beans, are also recommended. In addition to the plants just mentioned various others have been successfully and profitably grown as soiling crops. In this connection mention should be made of wheat, mixed grasses, teosinte, Kafir corn, sorghum, vetches, rape, etc.

At the Pennsylvania Station it was found that from 3 to 5 times as much forage was produced on an acre from soiling crops as from pasturage. Similar results were obtained at several other stations. Moreover, these conclusions are abundantly corroborated by the practical experience of the many dairymen who have adopted the practice of soiling. An intensive system of soiling will impoverish the soil if occasional crops are not turned under, leguminous crops frequently sown or plenty of manure returned to the soil.

Where leguminous plants have been directly compared with other plants, as at the Connecticut Storrs Station, they have proved superior. This is in accord with the findings of most investigators that a highly nitrogenous ration is most effective in the production of milk.

Soiling has found its widest application as a system of feeding milch cows. Some experiments have indicated that it is not profitable as applied to the feeding of pigs. Soiling was compared with pasture and feeding of hay at the Utah Station with the result that for fattening steers less feed was required for a pound of gain by soiling than from pasture or hay. Perhaps the best soiling crops for sheep are rape, vetches, alfalfa and oats and peas. A soiling system may also be adopted in feeding brood mares and colts.

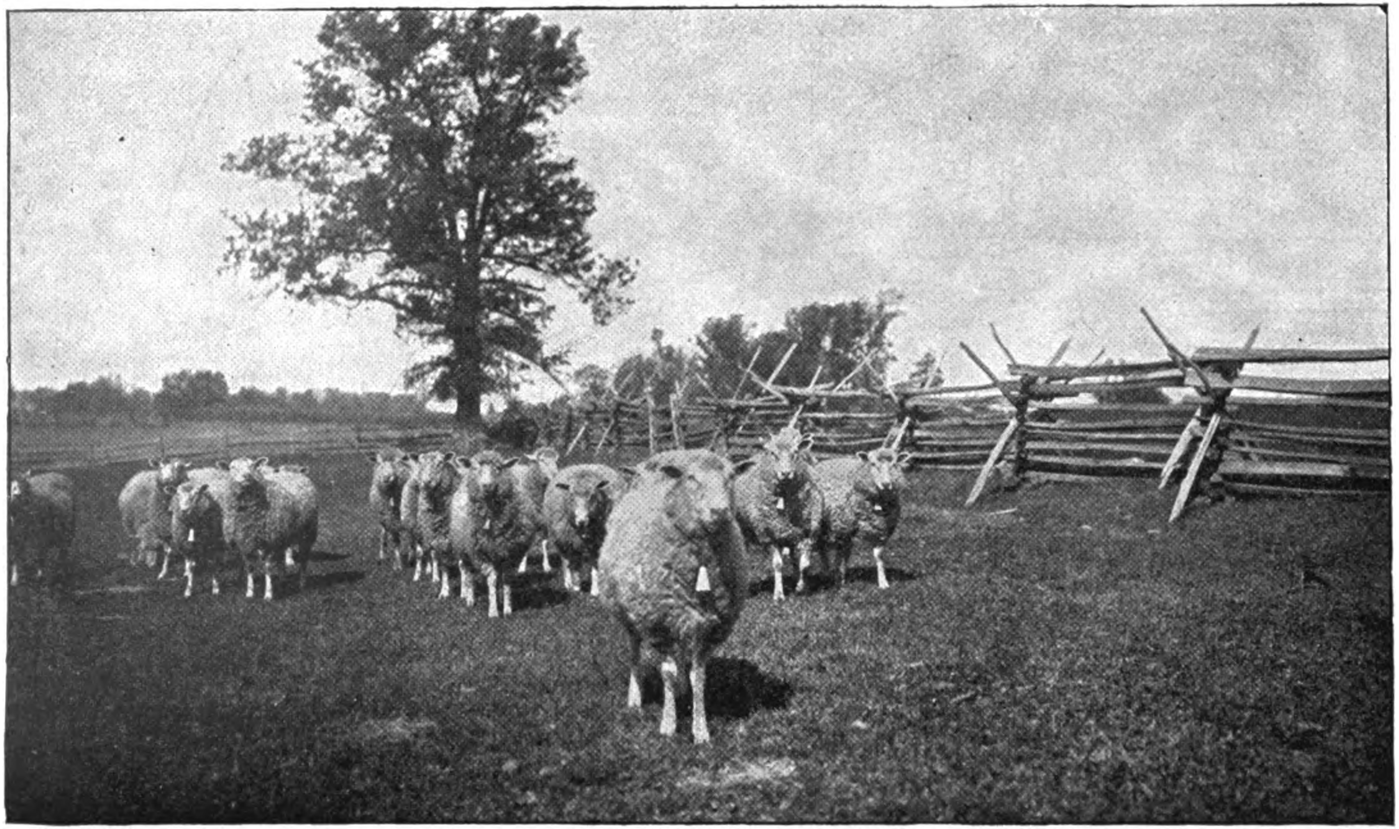
Green forage may be fed in stable or yards according to the estimated importance of exercise in any particular case, and the convenience of feeding.

At the New Jersey Station it was found that cows would eat about 60 pounds green forage per day in addition to a grain ration. Animals should be fed only as much as they will clean up, or if any fodder is left it should be taken out of the feed box before feeding again. It is recommended by Peer that dairy cows be fed 4 or 5 times per day. For further details see under the different farm animals, the annual reports of the New Jersey Station from 1897 to 1900, and "Soiling Crops and the Silo," by Thomas Shaw.

PART V

LIVE STOCK

Horses, Sheep, Swine, Principles of Feeding, Veterinary Medicines, Etc.



FLOCK OF LINCOLN SHEEP IN PENNSYLVANIA

FARMER'S CYCLOPEDIA OF AGRICULTURE

LIVE STOCK

FEEDING FARM ANIMALS

The chief purpose in feeding farm animals is to produce meat, milk, eggs, wool, etc., or energy in the form of work. Animals in a wild state eat enough to keep themselves alive and maintain their condition. They may take on a moderate amount of fat during the summer which serves to tide them over the winter season when food is scarcer. Man has interfered, however, for the purpose of securing greater production. One of the weighty considerations which has governed breeding experiments with domesticated animals is the idea of producing breeds which can consume large amounts of feed and make good use of it.

One respect in which improved breeds almost uniformly differ from native or unimproved animals, is the greater capacity of the stomach and intestines and the increased ability to give profitable returns from large quantities of feed. The greater digestive capacity, increased fertility and earlier maturity, if not accompanied with loss of vigor, make pure breeds or first crosses more profitable feeders than scrubs.

Rational feeding is based to a large extent upon the sciences of physiology and chemistry. The successful feeding of animals for profit, however, is an art and not a science. This fact is becoming quite generally recognized and there is a growing and laudable tendency to break away from the idea which has long prevailed, that successful feeding must conform to the mathematical formulas contained in the German feeding standards. These standard rations were computed from digestion experiments without reference to the comparative cost or convenience of obtaining the various feeding stuffs.

The chief problems before the practical stock grower are what feeds are most effective in animal production, in what amounts should they be fed for greatest profit, what combinations of feeds are most effective, and what effect have the various feeding stuffs on the quality of the meat, fat, milk, etc. But after these questions have been satisfactorily answered, the ration in any particular case will be compounded from the cheapest available feeding stuffs in suitable proportions. It would obviously be bad economy for a stock grower to haul one grain to market and haul another back, simply because the grain which he raised did not happen to be the one used in some successful feeding experiment. The economy of production of the various grains and coarse fodders will determine in almost every instance the ration adopted for a given purpose.

After an economical and effective ration has been selected, the farmer will of course set about to feed it so as to get the greatest possible returns. As a rule in fattening animals an attempt should be made to put them in condition for market within the shortest possible feeding period. For this purpose the animals should be gradually induced to eat a maximum amount of feed, all that they will eat up clean. Animals are much influenced by the quality and palatability of the feed. The feed stuffs should be clean and should be prepared in an appetizing manner. Attention to these little details may prevent the animals from getting off feed. In order to avoid loss of appetite and consequent checks in the process of fattening, changes in the grains and coarse fodders of the ration should be made from time to time. In such changes substitutions should be made according to the relative feeding value of the different materials. Suitable substitutions are indicated in the discussion of the feeding of each animal. (See *Cattle, Swine, Sheep, Dairy Farming, Chickens, Ducks,* etc.)

The ration must be adapted to the species of animal. It has been found by practical experience that certain feeding stuffs are injurious to certain kinds of domestic animals. For instance cottonseed, if fed persistently, will kill pigs, calves and chickens. It is a valuable feed, however, for fattening steers and for milch cows. The individuality of different animals of the same species may be quite striking, especially in their choice of feed and in the amount which they can use to good advantage. Different classes of animals also require different rations. In general, the ruminants require and can make good use of a larger quantity of coarse fodders than pigs or horses. These are matters which must be learned from practical experience and in which little help can be expected from theoretical science.

Composition of Feeds—Different feeding materials contain the important organic chemical compounds in different proportions. Some of these compounds are always mentioned in accounts of feeding experiments and should therefore be briefly defined here.

PROTEIN is a short term used to signify a group of compounds containing nitrogen. Nitrogen constitutes from 15 per cent to 19 per cent of these substances. The group is a very heterogeneous one and the different substances differ so greatly in physical and chemical properties that they have nothing in common except that they contain nitrogen. Protein is present in all animal tissues and is absolutely necessary for repairing the waste in these issues. Animals could not live for any long period without protein. The minimum quantity which is required, however, has never been determined with any accuracy. While the chief function of protein is to furnish material for building up the muscles, blood and other tissues of the body, it may, under certain conditions, form fat and later furnish heat and energy.

ETHER EXTRACT, as used in works on feeding, includes the various fats and oils in the feeding stuffs, which can be extracted with ether. In general, seeds and grains contain more fat than the coarse fodders, straws less than hays, and roots and tubers but little. Of the cereal grains, corn and oats contain the most oil, but the seeds of flax, cotton, sunflower, rape and mustard are very rich in fat. Peanuts contain a large percentage of oil.

CARBOHYDRATES is a term used to denote the starches, sugars, gums and similar substances in feeding stuffs. Nitrogen-free extract is also sometimes used as synonymous with sugars and starches, but it really includes certain other less important substances. The carbohydrates constitute the greatest portion of the dry substance in feeding stuffs. Starch is the most important member of the carbohydrates and forms the largest part of the dry matter of grains, and of the tubers of potatoes, rootstocks of cassava, etc. Commercial starch is largely obtained from corn, potatoes and cassava. Vegetable gums, some of which are known to chemists as pentosans, are found in considerable quantities in hay, corn fodder, sugar beets, wheat bran, gluten meal, etc. Sugars occur in smaller quantities than starches but their feeding value is greater. Saccharose, the common crystallized sugar of the market, occurs in fruits, grasses, sweet potatoes and other roots, but is most abundant in sugar cane, sorghum, sugar beets and corn fodder in a fresh condition. Grape sugar and fruit sugar are also found in various fruits and fodder plants. The carbohydrates, and the fats and oils, when digested in the animal body, furnish heat and energy. Until recently it had been supposed that this was their only function. Recent experiments, however, have shown that a large part of the animal fat may be derived from starch and sugar in the food. This explains the great feeding value of corn meal, which in practice far exceeds that computed from a theoretical standpoint. Experiments show that milk fat may be in large part derived from starch and sugar. The feeding value of fats and oils is much greater than that of starches and sugars. A part of the food fat may be directly modified into body fat or milk fat.

CRUDE FIBER is the tough, woody part of plants and consists largely of cellulose and wood fiber. These are the essential constituents of the cell walls of plant tissue. The proportion of crude fiber depends largely on the stage of growth of the plant. In young plants the cell walls are thin and delicate, while at maturity the same plants may contain a large proportion of tough fiber. Naturally coarse fodders contain a larger proportion of crude fiber than grain feeds.

Classes of Feeding Stuffs—The vegetable materials used in feeding farm animals may be conveniently divided into 2 classes: (1) Coarse fodders, including forage plants and roots, and (2) concentrates or grains, seed and the various by-products resulting from their commercial use.

The chief forage plants belong to the families of grasses and legumes. The grass family is represented by corn, cereals and common grasses, while the legumes include clover, alfalfa, peas, vetches, sainfoin, etc. As feeding stuffs the legumes differ from the grasses chiefly in the greater amount of protein which they contain. Coarse fodders as a class are distinguished from the grains by a smaller percentage of protein and carbohydrates and a larger percentage of crude fiber. Practically all of the forage plants may be fed green, dry or in the form of silage. The practice of feeding forage plants in a green state is known as soiling. (See this subject.) The relative advantages of feeding fodders green, dry and ensiled cannot be discussed here except in the briefest terms. As a rule forage plants are most palatable in the green state, and sometimes more digestible. Drying forage plants in the sun under favorable conditions does not affect their feeding value appreciably except in the case of corn, sorghum or other plants with thick, succulent stems which cannot be dried quickly. In such plants a certain amount of fermentation and consequent loss in feeding value is unavoidable. Forage plants are tougher and less palatable when dry than when green. Moreover if cured under unfavorable conditions (rain, cloudiness) they become moldy and seriously damaged. Imperfectly cured hay may suffer loss in feeding value from heating in the mow or stack.

In the summer season the farmer will choose between pasturing and soiling according to circumstances. In winter the choice will fall between hays and silage. As a rule hay and silage can be fed together to the best advantage. The stage of growth at which forage crops are cut will influence the amount, composition and palatability of the crop. With the exception of legumes forage plants give the largest yield when cut at full maturity. The percentage of protein, however, decreases as the crop matures, so that probably the best returns in quantity and quality are obtained if clovers and grasses are cut in full bloom. Legumes for forage should always be cut before becoming fully mature.

FORAGE CROPS when ensiled undergo important changes in composition, due to complex processes of fermentation. (See *Silage.*) The loss of food value in this way may vary from 2 per cent to 40 per cent, but under favorable conditions should not exceed 4 to 8 per cent. The loss in ensiling is not greater than that in field curing. In fact the results of experiments are slightly in favor of silage, as being the more economical way of preserving fodder.

ROOTS of various kinds are extensively fed to farm animals. The more important are turnip, rutabaga, field beet, sugar beet, mangel-wurzel, carrot, potato and cassava. Roots contain a relatively large amount of water. Their chief advantage is that they furnish a large amount of appetizing, succulent food which keeps fresh during the winter. They are easily preserved by keeping at a low temperature with good ventilation. If fed in proper proportions roots may be substituted for soiling crops, hay or silage. For details see experiments in feeding under the different farm animals. Roots may be fed raw, cooked or ensiled. There is little, if any, advantage in ensiling roots and most authorities advise against the practice. As a rule feeding stuffs are made less digestible by cooking. Some roots, especially potatoes, may be rendered more palatable by cooking.

GRAINS and SEEDS contain relatively little water and large amounts of protein, starch and oil. The chief grain feeds are corn, barley, oats, wheat, rye, rice, Kafir corn, millet, buckwheat, cottonseed, flaxseed and the different kinds of beans and peas. Peas, beans and oats are rich in protein, corn is especially rich in starch, while cottonseed and flaxseed have a high oil content. Experiments indicate that there is no advantage in cooking grains. The economy of grinding grains has been extensively studied and the results are fairly uniform. The digestibility of grains is increased by grinding and there is less waste of grain in the manure. If a mill is near at hand and the miller's toll is not high, it may pay to grind grain. If grinding adds 10 per cent to the cost of the grain the practice is of doubtful economy. Corn may be most economically fed to steers without even husking.

Commercial Feeding Stuffs—From milling and from the manufacture of special food articles from grains, a number of materials suitable for feeding farm animals are obtained. The more important of these may be briefly considered in this place.

Bran is the common term for the ground outer hulls of grains. Wheat bran is most extensively used. It is ordinarily fed to horses only once or twice per week. Bran is one of the best dairy feeds and is also excellent for fattening steers, sheep and lambs.

Middlings and Shorts are terms commonly used interchangeably. They contain bran and the outer part of the kernel of grains. Middlings are better feed than bran for young pigs. The middlings of all grains are good feeds for fattening animals.

Oat Feed consists of the hulls and a portion of the kernels of the larger oat grains, together with the smaller grains which are not used in the manufacture of breakfast foods. Sometimes the oat hulls alone are sold as oat feed. Such material is of inferior value. Oat feed, when honestly made, may be substituted for oats in feeding animals.

Barley Feed consists of the hulls and a part of the kernel of barley. Its feeding value is not equal to barley.

Corn furnishes a large number of commercial feeding stuffs, of which some of the more important may be mentioned. Hominy chops consists of a part of the starch, the germ and hull of the corn kernel. This feed closely resembles whole corn in composition. "Sugar corn" consists largely of the hulls and germs of corn. Gluten feed contains the hulls and gluten layer of the kernel, and gluten meal is made from the hard part of the kernel. Gluten meal contains the most protein and is a highly nitrogenous feed.

Brewers' Grains is a term used for the crushed grains (usually barley) after the sugar has been extracted for brewing. They contain relatively more protein than whole barley. Wet brewers' grains should be fed fresh, before they have undergone fermentation. They are extensively fed to dairy cows and are very valuable for this purpose. Brewers' grains, when dried, form a more concentrated feed. They may be shipped long distances and are easily preserved in good condition. Dried brewers' grains may be fed to dairy cows and are also useful for feeding horses and steers. They are less valuable for swine.

Malt Sprouts are the barley sprouts formed during malting and are later separated from the dried grains. They are highly nutritious but are not much relished by farm animals and hence must be fed in small quantities. They should be soaked before feeding.

Cottonseed Hulls are removed from the cottonseed preparatory to extracting cottonseed oil. The hulls are a low grade feeding product and are to be classed with coarse fodders. They are extensively fed in the Southern States in combination with cottonseed meal in the proportion of 3 to 6 parts hulls to 1 part meal.

Cottonseed Meal—The hulless kernels are cooked and then subjected to high pressure, by which the oil is removed. The process has been perfected so that the resulting by-product contains less oil than formerly. The pressed cakes are ground to form cottonseed meal. This product is highly nitrogenous and is one of the most valuable and effective stock foods. It is especially adapted to fattening steers and feeding milch cows. It is injurious or even fatal to pigs, calves and chickens if fed in long periods. When fresh and pure it should be of a light yellow color, and it should be fed only in this condition. Cottonseed feed is a mixture of the hulls and meal (usually in the proportion of 4 to 1), and its feeding value is less than that of the meal. (See also under *Cattle, Sheep, Swine* and *Dairy Cows.*)

Linseed Meal is a by-product of the manufacture of linseed oil from flaxseed. The "old process" consisted in subjecting the seeds to pressure, either while cold or after warming. By the "new process" the oil is extracted with naphtha. The old and new process linseed meals are almost identical in composition, except that the new process meal contains much less oil. Linseed meal contains a high percentage of protein. It has a beneficial effect upon the health and appearance of all farm animals. It may be fed to cows in rations of 8 pounds per day. Horses should receive only occasional feeds of linseed meal. It may be fed to skim-milk calves to replace the fat of whole milk. Flaxseed, cooked or ground, may be fed to calves and other farm animals, but it contains more oil than linseed meal and should be fed sparingly on account of its laxative effect. (See also under *Cattle, Dairy Cows, Sheep* and *Swine.*)

Feeding Stuffs of Animal Origin—The feeding of milk (whole or skimmed), buttermilk and whey is discussed under

Pigs, Calves and *Colts.* Slaughter-house refuse, meat scraps, meat meal, bone meal, dried blood, tankage, ground fish, etc., are much used as feed for poultry, and to some extent for hogs. These feeds contain relatively large amounts of protein.

Rations—All writers on feeding problems use the term nutritive ratio to signify the ratio between the digestible protein and the other digestible matter in any food stuff. In calculating the nutritive ratio the quantity of digestible ether extract or fat is multiplied by 2.4, since fats have 2.4 times the heat value of carbohydrates. The resulting quantity is added to the total amount of carbohydrates and the sum is divided by the amount of digestible protein. Thus timothy hay has 3 per cent digestible protein, 43.9 per cent digestible carbohydrates and 1.2 per cent ether extract. The nutritive ratio of timothy may therefore be computed as follows: 1.2x2.4 equals 2.88. This quantity added to 43.9 gives 46.78. By dividing 46.78 by 3, the amount of digestible protein, we obtain 15.5. The nutritive ratio of timothy is therefore expressed by 1 to 15.5. This is called a "wide ratio," on account of the large amount of carbohydrates as compared with the protein. The nutritive ratio of corn is 1 to 9.8, and this is considered a "medium ratio," while a good example of a "narrow ratio" is found in linseed meal, with a nutritive ratio of 1 to 1.7.

From the above discussion it may be seen that wide ratios may be made up almost or quite entirely of coarse fodders, and are therefore cheaper than narrow ratios, in which the increase of protein must be furnished by relatively expensive grain feeds. Wide and narrow rations are adapted to different purposes and should be fed with an understanding of their effects.

A ration which is fed for the purpose of maintaining an animal without gain or loss in weight is called a maintenance ration. Such rations may obviously be quite wide, since a relatively small amount of protein is required. Animals may be maintained upon good pasture or hay without grain. The best example of a maintenance ration of coarse fodder alone is furnished by grazing conditions in the Western States, where cattle, horses and sheep maintain themselves exclusively on the native grasses and weeds. About 15½ pounds mixed hay or 12 pounds timothy hay and 3 pounds wheat bran per day or their equivalents are required to maintain a beef animal of 1000 pounds' weight. For a 1000-pound horse 16½ pounds mixed hay, or 10 pounds timothy hay and 5 pounds oats, may be considered a maintenance ration.

In general, narrow or medium rations are more effective in the production of milk or for young growing animals, while wide rations are most effective and profitable for fattening animals. Protein seems to exercise a stimulating effect on the formation of milk, and experiments indicate that the quantity of protein in the average ration which is fed to dairy cows could be considerably increased with profit. Young growing animals, especially if they are to be used for breeding purposes when mature, require an abundant supply of protein in order to secure a vigorous development of all parts and organs. The effect of withholding nitrogenous food materials from growing animals is seen in the smaller size of the heart, lungs, liver and kidneys and the softness of the bones. The bones may become too weak to sustain the weight of the body.

For fattening animals, particularly if the feeding period is to be short, a wide ration is as effective, or more so, than a narrow ration. Whole corn or corn meal may be fed as the exclusive grain feed, or with an occasional addition of small quantities of wheat, oats, peas or beans. Where Kafir corn is grown it may be substituted for corn, and cassava may serve in part as a cheap substitute for corn. Hundreds of experiments have demonstrated that for fattening animals a moderately wide and cheap ration, with corn as the chief grain feed, is equally as effective as narrow rations containing more costly grains.

The numerous feeding experiments which have been made in this and other countries have demonstrated conclusively that the cost of gain in weight is greater at the end of a fattening period than at the beginning. Animals should therefore be put in market condition as quickly as possible. It has also been shown that the cost of gain increases and the rapidity of gain decreases with the increase in the age of the animals. For a discussion of these points see under *Swine, Cattle* and *Sheep.*

It has been found that cattle, sheep and pigs vary to some extent in their ability to make economical use of feeding stuffs. Up to the age of 3 months calves may make better gains than pigs on the same feed. In older animals, however, pigs make more economical gains than cattle. The following table, compiled from 75 or more experiments with 500 or more animals of each kind, indicates the average amount of different grains required for 100 pounds of gain in pigs, sheep and cattle:

GRAIN REQUIRED FOR 100 POUNDS OF GAIN

	Barley Lbs	Corn Lbs	Kafir corn Lbs	Oats Lbs	Peas Lbs	Wheat Lbs	Mixed grains Lbs
Pigs	418	485	529	472	439	452	432
Sheep	453	502	582	518	422	582	454
Cattle	914	1028	1058	1032	911	1090	871

It is generally found in feeding experiments that mixed grain feeds are more effective than single grain rations. In the above table it is also observed that the average amount of mixed grain feed required for 100 pounds of gain is less than the average of any 3 grains fed separately.

For details on rations see under the different farm animals. Consult also "Feeds and Feeding," by W. A. Henry, "The Feeding of Farm Animals," by W. H. Jordan, "Manual of Cattle Feeding," by H. P. Armsby, and "Principles of Animal Nutrition," 1903, by the same author.

HORSE

Horses stand in a peculiar relation to agriculture and are raised for different purposes than those which govern the production of other domesticated animals. While in European countries horses are used extensively for food, this practice has not become common in the United States. The main purpose in breeding horses is to secure motor power, either for slow or rapid work. The fact that farmers usually wish to maintain good horses for as long a period as satisfactory service can be obtained from them renders the care, feeding and management of these animals of unusual importance. With the majority of domesticated animals, except dairy cows, the common practice is to bring them to a market condition as soon as possible, and an attempt is usually made to secure this result before they have had opportunity to become infected with disease. With horses, on the other hand, the long service which they are expected to render subjects them to contagion and various diseases and to injuries which may result in impairing their usefulness. These facts make a study of the diseases of the horse of special importance.

The production of horses, like that of other animals, is subject to fluctuations, such as that caused by the recent heavy English demand for horses for use in South Africa. The extensive purchase of horses, especially in the Western States, has greatly increased the price of common horses and has stimulated their production in those regions. According to the latest census there are at present 18,600,000 horses in the United States.

The period of pregnancy in the horse is on an average 11 months, or 330 days. The weight of the foals at birth, from mares weighing 900 to 1100 pounds, is about 100 pounds, and the increase of weight varies from 1 to 3 pounds per day during early development. Naturally the weight of foals of different breeds at birth and their rate of growth vary to a large extent. According to experiments of Boussingault the normal variation in the weight of horses at different periods on the same ration and at the same kind of work may be 25 pounds or more. It has been shown that irritation of horses by the presence of flies or other annoyances may cause a sudden and rapid decrease in weight. During heavy work large quantities of water are lost through perspiration, and a decrease in weight of from 7 to 33 pounds in the working hours of a single day has been observed. The amount of work which horses are capable of performing under different conditions has been accurately determined by means of apparatus devised for that purpose. In general, it is known that the amount of work varies inversely with the speed. Horses are capable of doing a much greater amount of work at a slow speed than when driven rapidly. Experiments have shown that horses are capable of doing the most work at a speed of 2 miles per hour. The effect of severe work or rapid driving on the digestion varies somewhat in different horses, but usually the digestive process is somewhat checked by violent exercise.

The great majority of horses in this country are raised on farms as a side line by men who are chiefly interested in other branches of agriculture. As a result of these conditions many farmers give insufficient attention to the breeding of horses, and therefore produce an undue proportion of unclassed or nondescript animals which do not satisfy the market requirements and cannot be sold for a profitable price.

Market Classes of Horses—In the Chicago market 5 classes of horses are recognized: The carriage horse (Fig. 366), cab horse, bus horse, draft horse (Figs. 367 and 368) and American trotter. The carriage horse should be from 15 to 16 hands high and should weigh from 1000 to 1200 pounds. Bays, blacks, browns, sorrels and chestnuts are preferred. Peculiar markings and grays are not in favor. The animals should be round barreled, with large nostrils, small, clean heads, and should exhibit prominent veins on the face and limbs. Cab horses are raised for light delivery work. They should be from 15 hands to 15 hands 2 inches in hight, should weigh from 1050 to 1100 pounds, and should exhibit some style of action and ability to travel at a moderate pace, combined with power to haul medium loads. The bus horse of the Chicago market is the typical general purpose horse. The animal should be fitted to haul light loads at a fair rate of speed, should stand from 15 to 16 hands high, and should weigh from 1250 to 1500 pounds. The draft horse has but one use, and that is to haul heavy loads at slow speed. Strength is the first consideration. The animal should weigh from 1500 to 2000 pounds, should possess short back and should be closely coupled; the pasterns should be short, the hips broad and the bones large. The trotting horse requires too much attention for its successful production and can scarcely be raised economically by the average farmer. In breeding carriage horses the best stallions are American trotters, Morgan, Hackney or French Coach. Excellent specimens of them are seen in Figs. 369 and 370. Whatever breed is chosen, the mare should be of good form and should show tendencies to produce speed and style rather than weight and strength. In the production of general purpose or bus horses perhaps the best results can be obtained by breeding

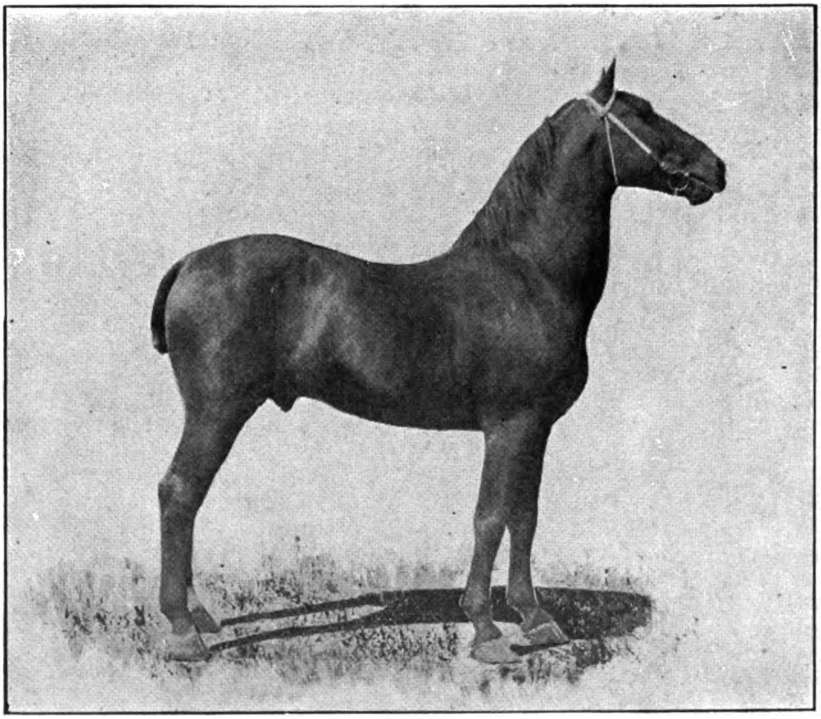


Fig. 366—WELL-BRED COACH HORSE

a Percheron stallion to a small mare with good action and well-developed bones. For draft horses only stallions of the best draft breeds should be used, and the mares should always be of large size and strength. In Fig. 371 are seen some fine types of saddle horses.

Management—The management of horses varies greatly according to the number possessed by any one man and according to the general conditions. In the Eastern States as a rule each farmer owns but a small number of horses, and these animals are always stabled or given shed room during winter and severe weather. In summer they are allowed to run, as a rule, upon cultivated pasture when not at work. The methods of feeding working horses do not vary greatly in different parts of the country, although the feed used differs according to the prevailing crop of the country. In the Western States, where horses are raised on a large scale, they are for the most part allowed to run on the open range the year round. Occasional losses are suffered from this method of management, and during recent years most horse raisers provide hay for use during the time when the ground is deeply covered with snow. As a rule the horses which have been produced on the Western plains have been of low grade and not well adapted to Eastern markets. They possess, however, great stamina and are especially well suited to driving or riding long distances on rough and heavy roads. The price of range horses has been as low as $10 to $15 per head, but on account of the large purchases by the English the price has been advanced to about $40 for common "bronchos."

Experiments at the Utah Station indicate that when horses are covered with blankets in the harness by day and blanketed also at night they do not retain their weight as well as horses without blankets. In later tests horses were irritated by blankets while at work. This does not prove that blanketing is not a good practice, but shows that excessive loss in weight may be caused by increased perspiration during heavy work under blankets.

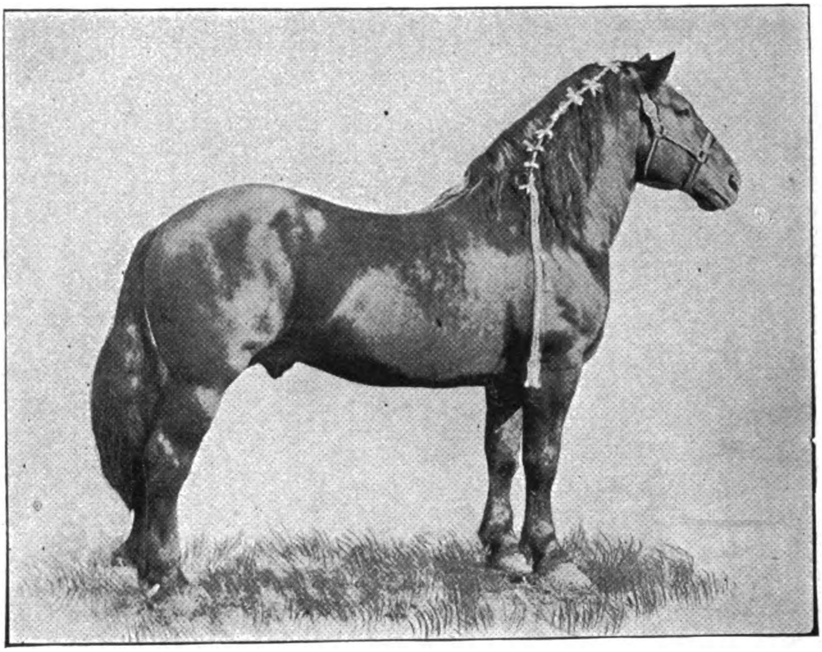


Fig. 367—A FAMOUS PERCHERON STALLION

A loss of appetite is frequently observed in horses under different conditions, and may be due to sore mouth, irregularities of the teeth, overfeeding or improper ration. The mouth may be made sore by punctures from grasses with sharp awns, such as the foxtail grass of the West. Irregularities in the teeth are indicated by the presence of uncrushed grain in the dung. The teeth should be examined from time to time in order to detect the presence of sharp points or other irregularities, especially on the grinders. An appetizing food recommended by the Rhode Island Station consists of 5 pounds oats, 5 pounds corn meal, ¼ pound oil meal and 2 ounces of salt, with the addition of a spoonful of powdered gentian and sulphate of iron as a tonic. Experiments have shown that systematic feeding in the right quantities and at the right time, with proper rations, prevents in a large degree the development of colic and other digestive disturbances which may interfere seriously with the work of a horse in careless feeding.

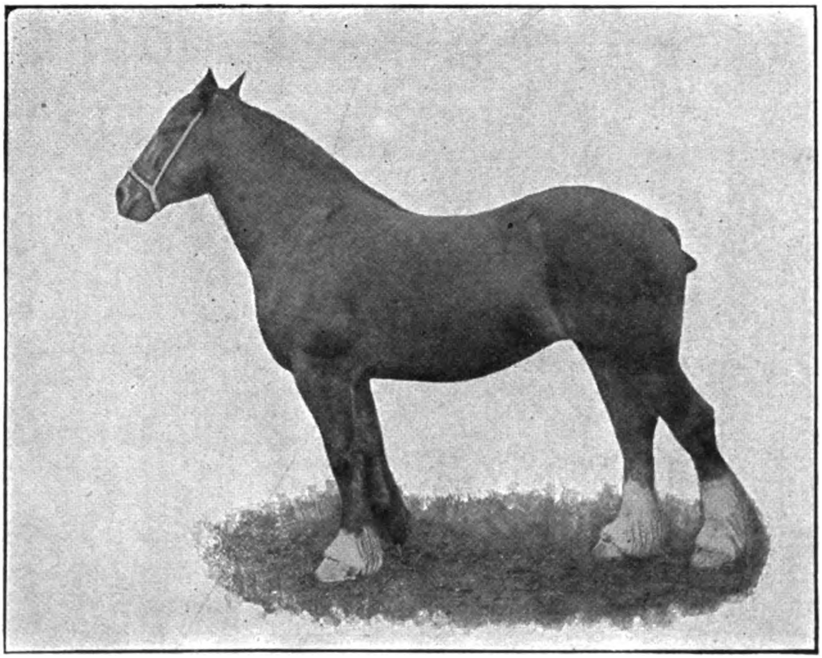


Fig. 368—HIGH-BRED CLYDESDALE MARE

The Age of a Horse Determined by the Teeth—At birth the foal commonly has no teeth in the front of the mouth and only 4 grinders in each jaw. After a few days the middle fore teeth appear, and after a month another grinder breaks through on each side of each jaw. After 4 months the intermediate fore teeth appear, and at the age of from 6 to 8 months the side fore teeth or corners appear and another grinder on each jaw. The set of milk teeth is then complete. At the age of from 13 to 16 months the cavities in the face of the middle fore teeth are effaced or razed, and the same process takes place in the corner teeth by the end of the second year. The shedding of the teeth and the beginning of the second set or permanent teeth occur at from 2½ to 3 years of age. The first or milk teeth may always be recognized by their shortness, whiteness, and by a constriction or neck. The middle front teeth are shed first, the intermediate ones follow at the age of from 3½ to 4 years, and the corner teeth are shed at from 4½ to 5 years of age. The determination of the age of horses between the years of 5 and 10 may be made with considerable certainty by experts from a study of the front teeth of the lower and upper jaws. Naturally these teeth undergo a progressive wearing process which changes their appearance as the animals grow older. In general it should be remembered that the shape of the front teeth gradually changes with age; in young horses they are wider from side to side than from front to back, while in very old horses they become wider from front to back than from side to side, having in many cases a triangular shape. As already indicated, a horse's mouth is said to be full, or dentition is complete at the age of 5 years. At 6 years of age the nippers become worn down even with the middle teeth; the inner edge of the corner teeth is also worn off. At 7 years of age the tushes show a dull, rounded point, both edges of the corner teeth are worn smooth, and the cavity on the face of the teeth is small. From this age until 10 or 11 the incisor teeth of the upper jaw are usually examined for determining age. The age is now indicated approximately by the amount of wear upon the face of the teeth and by the gradual disappearance of their marks or cavities. The marks in the corner teeth become obliterated at the age of from 7 to 8 years; the same processes take place in the fore teeth of the upper jaw more slowly, and when these changes have occurred in the upper teeth the horse may be looked upon as 10 years of age or older. The progressive formations of the horse's teeth are shown in Figs. 372 to 376.

Vices—Among the various vicious habits which horses may develop under improper or cruel treatment only one will be mentioned in this connection. Cribbing may become a very injurious habit. Horses addicted to this habit seize the edge of the manger with the teeth and bite the wood continuously, sometimes drawing in air with a sucking sound; this form of cribbing is commonly known as wind-sucking. The most effective remedy for this vice consists in the use of an open iron muzzle which keeps the teeth away from the edge of the manger, and which may be furnished with concealed goads which prick the lips if an attempt is made to continue the habit.

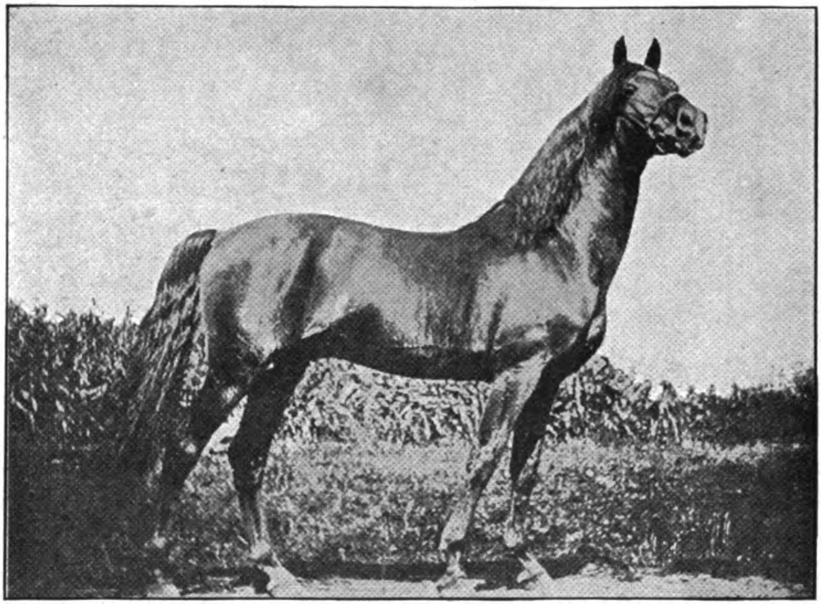


Fig. 369—WHITE RIVER MORGAN 487

Water—Many experiments have been conducted to determine the amount of water required by horses under different conditions. At the New Hampshire Station it was found that the amount of water taken by horses depended on the nature of the ration, on the work performed and on the individuality of the horse. The amount of water required appeared to depend more on the individuality of the horse than on the amount of work or the ration. The largest amount of water was drunk on a bran ration, and the least on a corn and linseed oil meal ration. The amount taken by different horses varied from 25,895 to 32,997 pounds per year. At the Oklahoma Station it was found that work horses drank on an average 107 pounds of water per day. At the Maryland Station experiments indicated that horses should be watered 3 times per day when at rest, but frequently and in small quantities when at work—never immediately before or after feeding. At the Utah Station, however, it was found that horses watered before feeding grain retained their weight better than those which were watered after feeding grain, and had better appetites. The grain was digested equally well whether the horses were watered before or after feeding, and it is recommended that the animals should be watered both before and after feeding on grain. The amount of water drunk by horses is smallest when the diet contains a large percentage of grains, and is greatest when the ration contains a large amount of coarse fodder. Less water is required on alfalfa than on a timothy ration. The excessive loss of water by perspiration during hard work shows clearly that working horses should be given water at frequent intervals, and experiments have shown that horses are not injured by taking small quantities of water, even during the most violent exercise and when heated and sweating profusely; the animals suffer far more by being compelled to wait for the water until they are completely dry and cool than from allowing small drafts of water at frequent intervals. (See also *Order of Giving Hay, Grain and Water* below.)

Grains for the Horse—Horse rations always contain a quantity of some kind of grain. The particular grain which is most used and most prized in different localities depends largely upon the abundance and cheapness of different grains in each section of the country.

OATS are generally considered, especially in the Northern States, as the standard grain for horses. Many horse raisers firmly believe that it is the only grain from which perfectly satisfactory results in feeding may be obtained. Oats are readily digested by horses and furnish an abundance of nitrogen. They may be fed in large quantities, causing no ill effects. The idea, however, that oats are the only proper feed for horses must be abandoned. The Arabian horses receive barley as an exclusive grain feed, and barley is the chief grain feed for horses in California and some other Western States. In the Southern States corn is used almost exclusively and with good results. Oats may simply be considered a standard grain feed for horses, and other grains may be substituted for oats in certain proportions, as will be presently explained. Some authors have maintained that oats possess a peculiar property, supposed to depend upon a substance known as avenine, which gives a desirable spirit and life to horses. It

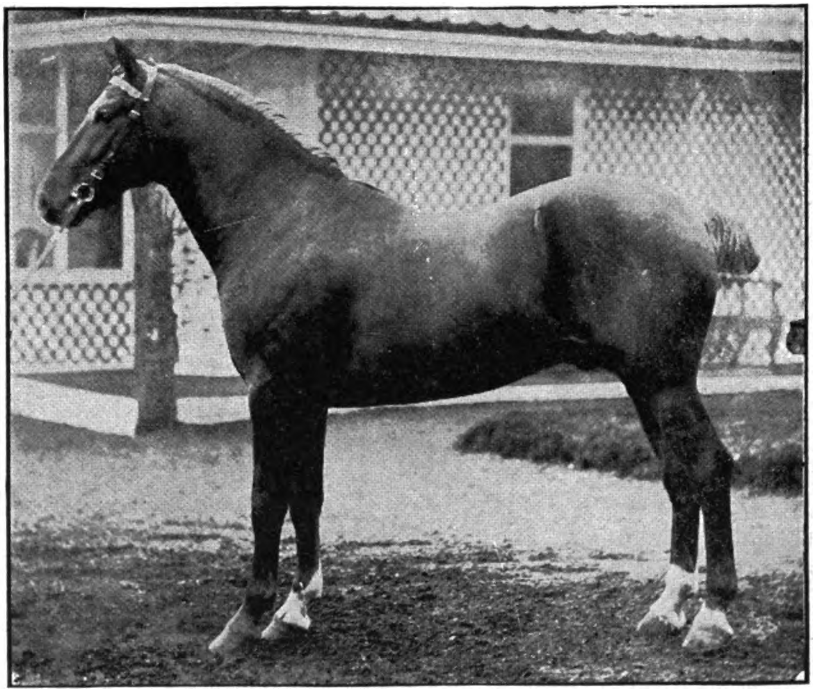


Fig. 370—HACKNEY STALLION

has been maintained that no other grain has this peculiar effect. The existence of this substance, however, has been denied by other investigators, and apparently as good results in spirit and action have been obtained from feeding other grains. When too expensive, oats should be replaced by some other grain, such as corn, barley, dried brewers' grains, or a portion of the oat ration should be replaced with these grains and wheat, or even buckwheat. According to some experiments oats are better digested when ground than when fed whole. Perhaps this grain is better digested by young horses than by old animals, and this may be due to imperfections in the teeth of old horses. With young animals which possess perfect teeth and good digestion there is apparently no sufficient reason for grinding oats before feeding. In an experiment in which oats were compared with a mixture of gluten meal, linseed meal and middlings for young colts, a greater growth was obtained from the mixture than from the oats alone. At the Maine Station slightly better gains in weight were obtained in colts fed on a mixture of pea meal and wheat middlings than from those fed on oats. The mixture was a cheaper food, and it is concluded, therefore, that oats are not a necessary grain ration for colts. Oats may be fed to the extent of from 8 to 20 pounds per day, according to the size of the animal and the severity of the work. In the Rocky Mountain and Pacific Coast States oats are frequently cut when the heads are in an immature condition, and in this form the whole crop is fed to horses and other animals. In some localities 2 crops per year are obtained. Smutty oats should not be used, since they may produce colic or more serious disturbances.

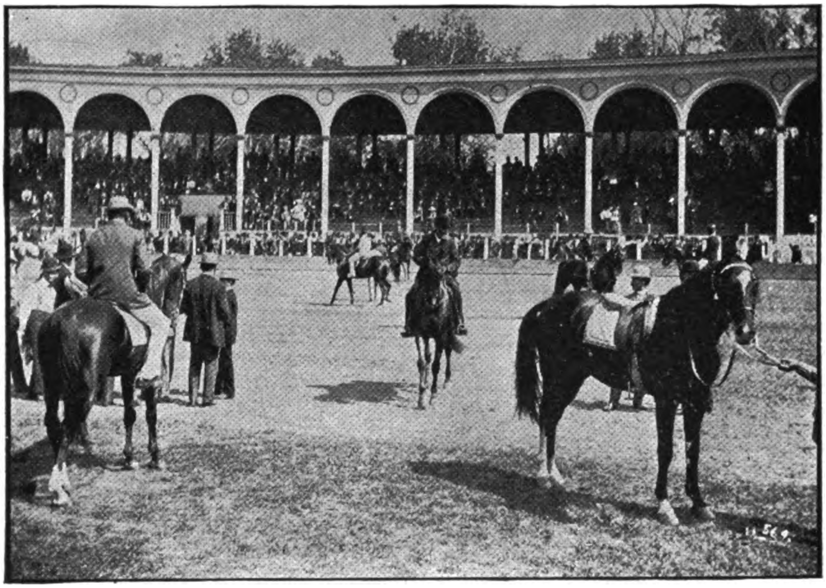


Fig. 371—SADDLE RING AT THE ST. LOUIS FAIR

Barley, as already mentioned, may be substituted for oats pound for pound, or in slightly larger quantities than the oat ration. It is better fed ground than whole. It appears to produce more fat than oats, and, according to some experiments, appears to exercise a depressant effect on horses. At the North Dakota Station experiments showed that barley was not quite equal to oats as a horse feed, and that malted barley was inferior to whole barley. Similar results were obtained by Marneffe. Hambro found that barley could be occasionally substituted for oats without any loss of weight in the horses. It is much used as horse feed in oriental countries, Spain, and in the Western States, especially in California. Lavalard's experiments showed conclusively that barley could entirely replace oats in the ration for all kinds of horses, whether for driving or draft purposes, but that it must be fed in slightly greater quantities than oats.

Beans of all varieties are fed to horses in common practice, and several experiments have been conducted to determine their feeding value. Lavalard found that beans could be substituted for oats in the rations of all classes of horses; that horses fed on beans showed a greater endurance than those which received oats. Beans are also recommended for stallions in service and for hard-working horses. Beans should be fed in about ½ the quantity of an oat ration, and straw and other coarse fodder should be added to the ration. Horse beans are especially recommended for horses at hard work. They are remarkably effective when used to replace 2 or 3 pounds of the oat ration. They may prove injurious to horses with thick wind or especial susceptibility to founder. Fresh horse beans occasionally cause colic. They should be fed cracked and only after lying for a year or more. The soy bean may enter largely into the horse ration, and Lavalard regards it as in some respects superior to other kinds of beans. In substituting for oats, ½ pound is equal to 1 pound of oats.

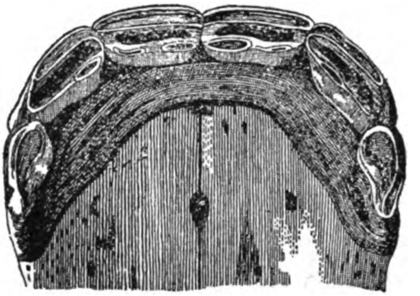


Fig. 372—HORSE'S TEETH, ONE YEAR OLD

Bran may be substituted for oats in the horse's ration, either in summer or winter. At the New Hampshire Station it was found that bran contained the same amount of digestible material as oats, and was $5 per ton cheaper. Undue quantities of bran may make the horses soft and inclined to sweat profusely. At the North Dakota Station bran and shorts mixed in equal parts were found to be equal to oats in feeding value, and in further experiments they proved to be slightly superior.

Buckwheat may be fed whole, but should usually be crushed or ground. It may be given in feeds of 4 to 6 pounds to replace that quantity of oats. In some horses it causes sweating and colic. In feeding value it stands between oats and barley, according to Wrangel. In some parts of Europe good results are obtained from feeding horses a bread made of buckwheat flour.

Cottonseed Meal is an excellent horse feed, at the rate of 2 to 2½ pounds per day. At the North Dakota Station it was readily eaten and caused no digestive disturbances or loss of appetite. It has a high feeding value and its cheapness recommends it for general use in feeding horses. At the New Hampshire Station it was not greatly relished by the horses, but was the cheapest of all rations with which experiments were made. In Louisiana 1 to 2 pounds per day were fed to mules with success. The maximum safe feed was found to be about 6 pounds.

Corn is, next to oats, the most important grain for horses, in fact, numerous and extensive experiments by street car companies in this country and in Europe have shown that its feeding value is equal or in some cases superior to that of oats. As already stated, it is the principal grain feed of horses and mules throughout the Southern States. At the Utah Station corn sustained the weight of horses better than oats. A ration containing corn and oats proved of greater value than one containing oats alone, and at the North Dakota Station it was found that 77.5 pounds of corn equaled 100 pounds of oats for work horses. The Leipsic Street Car Company, in experiments along this line, found that horses kept in better health and showed sleeker coats on a mixture of corn and oats than

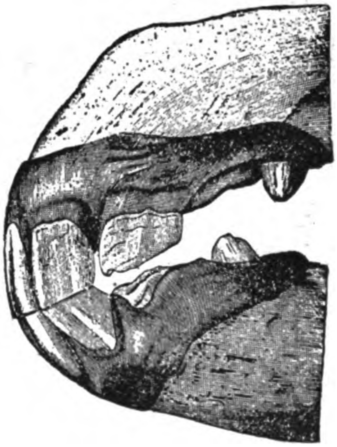


Fig. 373—FOUR AND ONE-HALF YEARS OLD

on an exclusive oat ration. Of 26 street car companies in Germany, 22, after extended experiments, reported in favor of replacing ¾ of the oats with corn. In 1870 the general livery and omnibus companies of Paris began feeding corn; the results were so satisfactory that one company, using nearly 10,000 horses, entirely abandoned oat feeding, and the other replaced a large proportion of the oat ration with corn. A great saving was thereby effected. Lavalard found that corn could be substituted for oats in the ration of driving, work, cavalry or artillery horses. In his experiments corn gave results which were equal to those obtained from oats in the muscle, health and spirit of the horses. At the Oklahoma Station excellent results were obtained from feeding work horses 30 pounds of corn in the ear and 31 pounds of Kafir stover per day. The Maryland Station found that corn meal was more readily digested than shelled corn; the horses had better appetites when fed on the meal, especially in the case of old animals.

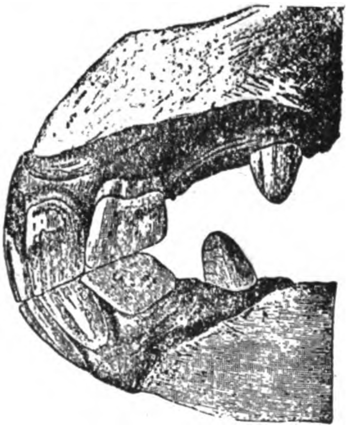


Fig. 374—FIVE YEARS OLD

Dried Brewers' Grains, at the New Jersey Station, were found to be equal to oats, pound for pound. Horses ate them with relish and remained in good condition. In experiments by the German War Department they were found to be of uncertain composition and their use was abandoned, but when properly dried their composition remains fairly constant. Subsequent tests at the New Jersey Station showed that dried brewers' grains were equal to the same weight of a mixture of wheat, bran and linseed meal.

Kafir Corn and Kafir stover were extensively fed to horses at the Oklahoma Station. Kafir corn was not eaten clean by some of the horses, but it was considered a safe, economical and valuable feed.

Linseed Oil Meal may be given to the extent of 4 pounds per day with no ill effects. A change may safely be made from a ration containing the oil meal to one without it, if proper substitutions are made. Flaxseed has a laxative effect, and mixed with oats is an indispensable supplemental feed in derangements of the digestion. It should be cooked into a pasty mass and then mixed with the other feed.

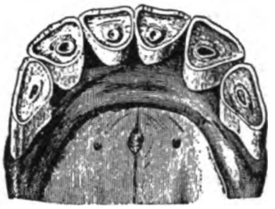


Fig. 375—EIGHT YEARS OLD

Millet seed is recommended by Stewart for horses of all ages as being adapted to maintain muscular strength. It should constitute only a portion of the grain ration and should be ground. It should not be given continuously for a long period. At the North Dakota Station millet cut just before becoming mature and fed as exclusive coarse fodder produced increased action of the kidneys, lameness and swelling of the joints and a softening of the bone structure. In a few cases extensive feeding resulted fatally. These observations have not been generally confirmed.

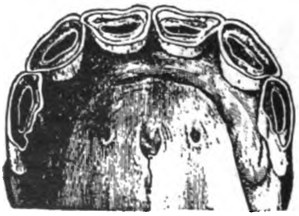


Fig. 376—FOURTEEN YEARS OLD

Peas constitute an excellent and highly nutritious horse feed. They are about equal to beans in feeding value. Peas occasionally exercise a somewhat constipating effect. Stewart found that a ration containing 8 parts of peas, 8 parts of corn and 1 part flaxseed, the whole being ground together, gave satisfactory results with work horses. Peas are extensively fed to street car horses in Europe and in this country. Pea meal was fed by Stewart to the extent of 16 pounds per day, mixed with 1 bushel of cut hay. This ration was found to be well adapted to sustaining the weight and strength of horses at hard work.

RYE may replace 1-3 of the oats in the grain ration. It should be cooked or moistened. If infested with ergot it may cause serious disturbances, and therefore should be fed sparingly until it is demonstrated that the grain is clean. Stewart found that rye ground and mixed with hay formed a healthy and suitable ration. Lavalard substituted rye for oats, pound for pound, with varying but for the most part satisfactory results. The composition of rye from different localities was found to vary considerably. Rye bran may be mixed with new corn for the purpose of preventing scouring.

WHEAT when fed whole was found to be an unsatisfactory ration at the North Dakota Station. The horses lost appetite and refused to eat the grain after a time. When ground and mixed with bran it gave excellent results. Whole wheat was found to be no better and probably not so good as an equal quantity of bran and shorts, while a ground wheat and bran ration gave better results than did oats for horses at light work. In Sweden experiments showed that wheat was superior to rye, and it is therefore recommended as a horse feed, mixed with an equal quantity of oats. During hard work 10 pounds per day may be given with oats. It has been found to have a beneficial effect in building up the muscles of horses which were run down by hard work and in sustaining them during excessively severe labor. When fed in large quantities it may cause digestive disturbances.

At the Iowa Station greater gains were obtained in colts by feeding on ground than on whole grain. The grain in these experiments was oats, corn and rye. These results were confirmed by further experiments. One lot of colts received corn and cob meal and bran, and the other shelled corn and whole oats. Better results were obtained on the first ration. It was found in these experiments that weanlings require about 7½ pounds of grain for 1 pound of gain, while yearlings require 11 pounds. At the Utah Station whole grain was found to be equal to ground grain for work horses, and from the expense of grinding it was concluded that grain must be from 15 to 20 per cent more effective when ground in order to pay for the grinding. Later experiments indicate that grinding was unprofitable. The question of whether grain shall be ground or not before feeding is largely a practical one and depends principally upon the kind of grain which is fed and upon the condition of the horse's teeth and digestion. When the teeth are in good condition there appears to be no good reason for grinding oats or wheat or barley, when these latter grains are substituted in part for the oats.

Coarse Fodders for the Horse—In the Northern States timothy is the standard hay for horses and is considered by many as the only satisfactory hay. In the Southern States, however, corn stover constitutes the chief coarse fodder, and in the West alfalfa, barley, wheat, oats and wild oats are cut for hay. The coarse fodder which is chosen for horse feed in any particular locality will depend upon the crop of this kind which is most abundant and cheapest.

ALFALFA is abundantly fed to horses throughout the Western States. Practical experience shows that it is superior to timothy in feeding value. When fed green it may cause digestive disturbances if horses are unaccustomed to eating it. When dry and clean, however, these effects are not noticed. In experiments by Muntz alfalfa proved to be superior to meadow hay in nitrogenous material and inferior in its starch contents. Wherever alfalfa is one of the chief fodder crops it largely replaces clover, timothy and other grasses as coarse fodder for horses and other domesticated animals. In Wyoming 13.5 pounds of alfalfa proved a daily maintenance ration for horses allowed the liberty of a straw stack. In Utah Merrill found that 20 pounds per day was enough to maintain a horse weighing 1400 pounds when at rest. Alfalfa proved superior to timothy in every way and produced no bad effects after long continued feeding. Alfalfa and clover when cut into fine pieces resulted in greater gains than when fed uncut.

BROME HAY, in experiments at the North Dakota Station, proved to be equal or slightly superior to timothy. This crop has not come into great economic importance in this country, but wherever it is grown in quantities sufficient to make the market price reasonable it may be substituted for timothy pound for pound.

CLOVER HAY has been found to be more nutritious than timothy, but is feared by nearly all horsemen on account of its tendency to produce heaves and other disturbances in respiration when fed in a dusty or unclean condition. These objections, however, do not apply to clean, properly cured clover hay, and there seems to be no good reason why it should not be fed extensively when preserved in good condition. At the Utah Station it was found to have a much greater feeding value when chopped fine.

CORN SILAGE at the Virginia Station proved to be a good roughage for horses when fed in connection with hay or corn stover, but it is recommended that horses be gradually accustomed to it before receiving full feeds. Moldy or improperly fermented corn silage may produce serious digestive disturbances or death with symptoms resembling those of cerebro-spinal meningitis.

CORN STOVER at the New Hampshire Station was found equal in feeding value to timothy hay. The large yield per acre makes it an economical feed. Further tests at the same station indicated that corn stover was slightly superior to timothy. It should also be remembered that it is usually much cheaper.

NEW CORN PRODUCT is a term used for ground stalks and leaves of the corn, minus the pith. At the Maryland Station it was found to contain 7 pounds more digestible matter than timothy in every 100 pounds. New corn product may be compressed, together with ground grains, the whole constituting a complete and convenient ration for army and pack horses. The whole ration can be fed from a nose bag. The new corn product is greatly relished by horses and may be used as a complete substitute for hay.

PEA PODS AND STRAW are fed in many parts of the country as a substitute for hay. They closely resemble timothy hay in composition, and when cut fine were found by Lavalard to be more easily digested. In Montana it was found that horses could be successfully maintained at hard work on a ration of pea straw with a small feed of grain. The pea straw, however, had a slightly irritating effect upon the kidneys, and it was found desirable to alternate occasionally with other coarse fodders.

STRAW may be used as a substitute for hay in any ration. It is, however, not equal to the best grades of hay. In relative feeding value the different kinds of straw stand in the following proportion: Oats, barley, wheat, rye. Oat straw is a very satisfactory feed. Horses require 1/4 more grain, however, when fed straw than when fed hay. At the North Dakota Station it was found that the saving in hay more than balanced the extra cost of grain, and the straw ration was therefore cheaper.

TIMOTHY is less completely digested by horses than by ruminants. It is, however, eaten with great relish, and, as already indicated, is preferred by nearly all horse raisers. At the Maryland Station it was found to be somewhat inadequate for maintenance when fed alone. In Utah, timothy when cut up fine produced sore mouth.

Roots and Miscellaneous Feeds—A number of experiments have been made to test the feeding value of different roots in horse rations. As a rule these feeds are given, not for their nutritive value, but for the medicinal effect which they may exercise upon the digestive organs or upon the kidneys.

ARTICHOKES are readily eaten by horses. They may be substituted for half of the hay ration with good results. For this purpose about 30 pounds per day are required.

CARROTS exercise a laxative effect and stimulate the stomach and kidneys. They are recommended in colds and digestive disturbances, but cause sweating and should not be fed to hard working horses except sparingly. They should be fed cut fresh in thin slices.

POTATOES have not proved suitable as feed for high-bred horses. They are not readily digested and may occasionally cause abortion. They should always be cooked, and may then be fed to common horses in the proportion of 12 pounds to 5 pounds of hay.

RUTABAGAS are usually fed as appetizers. They are eaten in large quantities by horses, but have small nutritive value.

MILK was found to give highly satisfactory results in feeding colts at the Iowa Station. When the mare's milk is too scanty, new cow's milk can be given to the extent of 2 quarts per day, and later may be replaced with skimmed milk, which may be increased to from

4 to 6 quarts per day, and may be fed until the colts are 1 year old. It produces rapid gains and good quality in colts and may be fed to them with as good returns as when given to calves or other animals.

Molasses was fed to 400 horses in experiments in the Fiji Islands. As much as 30 pounds per day was given, but it was recommended that 15 pounds be adopted as a feed, in connection with bran, corn and green sugar cane tops. In these experiments molasses proved a satisfactory substitute for starchy feed. No undue fatness or softness was observed in the horses and the ration was readily eaten with beneficial results in the health of the animal. The Copenhagen Milk Supply Company found that 3 pounds of blood molasses feed was equal to 4 pounds of oats. Molasses has been fed successfully also in France, Holland, United States and elsewhere. In Louisiana, mules were found to relish 8 to 10 pounds of molasses per day. Berns found that light horses could be maintained on 3 quarts of molasses and 15 pounds of cut hay per day. Molasses was also given in feeds of 1 quart diluted in 3 quarts of water to heavy horses at hard work. Berns concludes that good molasses is a nutritious, easily digested food for horses and has a tendency to prevent digestive disturbances. A sudden change from oats to molasses mixed with other material is quite safe, and economy in feeding may thereby be accomplished. In Porto Rico Griffin found that 13 to 15 pounds of molasses and 35 pounds of grass constituted a maintenance ration for a horse weighing 1000 pounds.

Rations for Horses—The rations commonly fed to horses vary greatly in different parts of the country, according to the cheapness and abundance of different crops. In the Northern States the standard ration consists of oats and timothy hay; in the Southern States the prevailing ration is corn stover and corn, while on the Pacific Coast the common ration is barley and oat hay or wild oat hay. In other parts of the world still other rations are commonly fed, and the general results obtained from these different rations are about equally satisfactory. It is perfectly evident, therefore, that feeding horses is an art and not a science. After a horse raiser has acquired a certain amount of practical experience in feeding one ration, that ration in his hands gives satisfactory results. The same feeding materials might be given with unsatisfactory or disastrous results by other persons who have not had experience with those particular materials. No farmer in the Southern States would consider it practical to buy oats and timothy hay for feeding his horses simply because that ration was found satisfactory in the Northern States. There is no one ration for horses. A combination of suitable and economical feed stuffs should be made according to the abundance of the crop and prevailing market prices, and various substitutions may be made, as indicated in discussing the various feeds.

At the Utah Station corn meal and timothy did not sustain work horses as well as oats, wheat and clover hay as a summer ration. In winter the first or wide ration was equal to the second or narrow ration. In summer a narrow ration was found to be better for work horses than a wide ration. At the Utah Station a moderate grain ration was found to be more effective and economical than heavy ones. It is recommended that the proportion of grain be smaller in summer than in winter. The New York street car companies found that horses did well on a ration of cut timothy hay and corn meal alone. At the New Hampshire Station experiments with 5 different rations showed that all were effective for work horses. Each ration had 10 pounds of hay per day; the other feeds were oats, corn, bran, gluten feed, linseed oil meal and cottonseed meal. A ration containing gluten meal was satisfactory in every respect. The ration containing corn and oats was the most expensive. The corn and bran ration was the most relished by the horses and was moderate in cost. At the Maryland Station excellent results were obtained from mixed feed containing 50 parts new corn product, 10 parts hominy chop, 10 parts ground oats, 10 parts ground rye, 10 parts linseed meal, 5 parts gluten meal, 5 parts wheat bran. It was relished by the horses and gave greater gains than a ration of corn, oats and new corn product, or of corn, oats and timothy hay. The Maryland Station determined by experiment that an exclusive grain ration is not good for horses. They soon lose appetite and refuse to eat an exclusive oat diet.

Extensive experiments conducted on 6000 horses by the London Omnibus Company demonstrated that horses thrived best on a ration containing chopped hay mixed with ground grain. It was found that both the grain and hay were better digested when mixed together before feeding. In Utah, however, cutting and mixing hay and grain proved an unprofitable practice. At the New Hampshire Station the average total cost for feed for working horses was 3.4 cents per hour's work, or $74.32 per year. The cost of the ration, however, will naturally vary almost indefinitely according to the materials which are chosen and their market value. In Canada the daily cost for feed for a farm horse was 27 1-3 cents.

Feeding and Care of the Foal—When the mare's milk is abundant no extra feed is required for the first few days. It is well, however, to accustom the young colts to feeds of grain as soon as possible. After a few weeks they may be safely given 2 or 3 quarts of oats per day with good results in weight. As indicated in the discussion of milk, this material may be given in as great quantities as will be taken without danger. It produces rapid gains and has great influence upon the form and spirit of the developing colt. Milk may be fed fresh or skimmed. Since mare's milk contains slightly more sugar than cow's milk, a small quantity of sugar may be added for the first few feeds, but it does not seem to be necessary.

Feeding Stallions, Mares, Road Horses, Work Horses—The rations for different classes of horses will naturally vary according to the purposes for which they are fed, according to their age and according to the severity of work which they are performing. It is not necessary in this connection to indicate the numerous successful rations which have been devised for horses of different classes and for stallions and mares. Naturally stallions require a more extensive grain ration during the period of active service. Mares should be fed during the period of lactation on foods which will supply tissue forming substances and also produce an abundant flow of milk. Care should be taken not to feed substances which might disturb the digestive condition of the colt. It should always be remembered that the peculiar properties of feeding materials may readily be transmitted to young animals through the milk. In fact, disturbances may often be produced in the young, while the mother animals show no effects of the particular feeding material.

The Order of Giving Hay, Grain and Water—In discussing drinking water for horses it has already been stated that water should be given at least 3 times per day to horses at rest, and much more frequently to horses while at work. The order in which hay, grain and water are to be given has led to extensive discussions and some experiments. Horses at work may safely be given small quantities of water at any time, whether they are greatly heated or not. Theoretically, the system of feeding should require that the horse be given water first, and that the grain be not given until after some of the hay has been digested. In practice, however, this is frequently impossible, since it would require a too long feeding period in the middle of the day. In general, horses should not be given large feeds of hay at noon if they are to be worked in the afternoon—in fact, the hay may well be entirely omitted in the middle of the day. The usual custom among horsemen, which is followed with perfect safety, is first to water the horse after stopping work at noon, and then give the grain ration after a few minutes. In general, it will be found necessary to feed grain before the hay, for the reason that the animals remain impatient until they receive their grain. The stomach of a horse is small, and since a feed of hay following upon the grain ration would necessarily force a large proportion of the grain out of the stomach before digestion was complete, it is desirable to allow a considerable interval in the evening ration, between the grain feed and the hay feed. In Utah, Merrill recommends watering both before and after feeding.

Fattening Horses for Market—Horses of any age bring a better price in a fat than in a poor condition. It is advisable therefore to feed a fattening ration for a liberal period before marketing the animals. Horses may be made to gain from 3 to 5 pounds per day for a period of 2 months by suitable rations. Fattening rations should include soft feeds. For this purpose the *Breeder's Gazette* recommends a mixture of barley, roots, corn meal and bran. Sugar beets may be mixed with barley of a No. 4 grade at the rate of 25 pounds to the bushel of barley. The whole should be boiled until quite soft. To every 3 pounds of this mixture 2 pounds corn meal and 2 quarts bran may be added and fed warm mixed with an equal bulk of cut hay or straw. This is a good ration for a single animal. The horses should be gradually accustomed to linseed meal until 1 pound per day is fed. Give plenty of salt and water. Care should be exercised to prevent the horses from getting off feed or developing colic at the beginning of the fattening period.

Diseases: MEDICINES—For an account of the medicines and of the doses mentioned under the diseases below see *Veterinary Medicines.*

GLANDERS, also called farcy and nasal gleet, is a malignant contagious disease due to the action of the glanders bacillus. The disease is most common in horses, asses and mules, but may occur in nearly all of the domestic animals except cattle. Man sometimes becomes infected through wounds. Glanders is almost uniformly fatal, but the course of the disease may vary from a few weeks to several years. Three forms of the disease occur, pulmonary, nasal and skin forms. In pulmonary glanders the lungs are the chief seat of infection and contain tubercles of different sizes, depending on their age. At first they are so minute as easily to escape detection. The tissue in the larger tubercles breaks down and pockets are thus formed which contain pus. Such pockets may be detected by cutting a smooth section through the lungs with a sharp knife.

In nasal glanders the chief symptom is chronic catarrh. The discharge may be interrupted at intervals, but soon begins again. The division wall in the nose is attacked and pustules form on this structure. Later the pustules break down and slough off, leaving pits or ulcers with ragged outline. The ulcers are frequently located too far back to be visible from the outside.

The skin form of glanders is called farcy, and the characteristic symptom is the presence of swellings in the lymphatic glands just beneath the skin of various parts of the body, especially on the hind legs. These farcy buttons may be accompanied by general swellings of affected parts. In stallions the testicles are usually affected during the first outbreak of the disease. The different forms of glanders are not distinct diseases, but are caused by the same bacillus, and frequently all the symptoms are present in one case.

Not only are the lungs, lymphatic glands and mucous linings of the nose affected, but during the progress of the disease the liver, spleen, kidneys, pancreas and other organs are invaded by the glanders bacillus.

A dry cough is usually noticed, especially after active exercise. The submaxillary glands are frequently swollen and sensitive. They may be felt by pressing against the inside of the lower jawbone from the under side of the throat. In health these glands are soft and not readily recognized by the touch. When attacked by glanders they become hard and knotty and slip back and forth under pressure of the hand.

Many of the symptoms may be absent in certain cases. In cases of recent origin or of slow development, where the external symptoms are not well marked, mallein has been found a most valuable agent in the detection of glanders. Mallein is a product of the glanders bacillus containing the active toxin or poison, but no living bacilli. It cannot produce glanders in healthy horses and does not have any noticeable effect upon them. In glanderous horses a hypodermic injection of mallein causes an elevation of temperature and certain other reactions. The method of making the mallein is the same as that of the tuberculin test. (See *Tuberculosis* under *Cattle.*) The method is in general use in detecting glanders in its incipient stages.

There is no satisfactory medical treatment for glanders. Some experiments have indicated a curative action of repeated doses of mallein, alone or combined with creolin. Good care and a nutritious diet may enable glanderous horses to live for several years, but in the meantime they may spread the contagion. All glanderous animals should be killed immediately and burned or carefully buried. (Mich. Bul. 78; Mont. Bul. 4; S. D. Bul. 25; Bureau of Animal Industry, Spec. Rpt. on Diseases of the Horse, p. 514.)

TETANUS or lockjaw is a virulent disease characterized by permanent muscular contractions which are due to an intoxication of the nerve centers by the products of the tetanus bacillus. Nearly all the domestic animals are subject to the disease. It is most common in horses and mules and rare in cattle. Tetanus sometimes occurs in cows in abnormal parturition. The disease often arises from infection in the wound in operations such as castration, docking the tail, etc. A prominent symptom is the continued muscular spasm, which may be increased in severity by any fright. Different parts of the body are attacked in different cases. Sometimes the muscles of the head and throat are chiefly affected, in other cases those of the neck and back or of one side. The general sensitiveness of the animal is increased and the slightest noise may produce fright. The head and tail are usually extended and the movements of the animal are stiff. A grating of the teeth is often observed.

The tetanus bacillus is common in floors of stables and in gardens, and wounds received in such situations may result in the development of tetanus. As a preventive treatment it is advisable to give proper antiseptic care to wounds. In the treatment of tetanus good results have been obtained by the use of anti-tetanus serum. This serum is prepared from the blood of horses recovered from tetanus, and produces immunity to tetanus in man or horses. In large doses it has given good results after the first symptoms of the disease have appeared. A veterinarian should be called to administer this treatment. U. S. Dept. Agr., Spec. Rpt. Diseases Cattle, p. 126; Spec. Rpt. Diseases Horse, p. 213.)

CEREBRO-SPINAL MENINGITIS is a non-contagious disease which occurs among horses in isolated cases or occasionally in extended outbreaks. The disease is not well defined and probably several different affections have been referred to under this name. Similar, if not identical, diseases have been called grass staggers, choking distemper and blind staggers. Horses of all ages and both sexes are affected. Temperament and physical condition do not alter the susceptibility to the disease. Mules are also attacked and mortality among them is as great as among horses. According to some European authors, the disease is due to the presence of a micro-organism in the brain membranes. Similar conditions were found in a recent outbreak in Maryland. The disease has been attributed by different writers to ergot, smuts and other fungi which are supposed to be taken with the food. In some instances improper feeding has been considered the cause of the disease.

The symptoms are staggering gait, partial or total inability to swallow, muscular contractions and delirium. In violent cases treatment is seldom successful, while in mild forms the administration of cathartics, tincture of aconite and blisters on the neck, spine and throat, give some relief.

A trouble among horses which had acquired the name "new horse disease," was investigated in Maryland, and was believed to be cerebro-spinal meningitis. Whenever symptoms of the disease develop, molded grain or fodder should be at once rejected and a general change of diet should be made. It has been recommended that horses should be placed in slings at the beginning of the trouble and that cold water or crushed ice should be applied to the head. Favorable results have been obtained from the use of ergot, aconite, belladonna and strychnin. In an outbreak of this disease which occurred in Delaware, the following feeding stuffs were suspected of having caused the trouble: decayed corn silage, musty oats and wheat bran. Direct feeding experiments with suspected substances for the purpose of determining their action in causing cerebro-spinal meningitis have usually been without result. Grain screenings containing a large proportion of cockle seed, wheat bran infested with stinking smut, and moldy oats, failed to produce any symptoms of the disease in horses when fed to them for the purpose of experiment. The disease needs further investigation. (Del. Expt. Sta. Rpts. 1893, p. 23, 1895, p. 60; Md. Expt. Sta. Bul. 53.)

PNEUMONIA in the horse may affect both lungs but usually attacks the right lung. The first symptom is usually a chill, after which the breathing becomes more rapid and the animal holds its head in a low position. There is considerable elevation of temperature, the pulse is frequent and hard or sometimes weak and irregular. A dry cough is noted at the beginning and occasionally there is a discharge from the nostrils which is somewhat colored with blood. Constipation is an almost constant symptom and the legs are cold. In treating pneumonia, good ventilation should be given without exposure to cold air or sudden changes of temperature. Plenty of cold drinking water should be given, the legs may be rubbed and bandaged after application of liniments. Considerable benefit may be derived from hot applications to the chest by means of woolen blankets. In some cases bleeding may be slightly beneficial, but it is not to be generally recommended. The use of aconite is also to be deprecated, especially if the pulse is somewhat weak. After evidences of fever are gone, a good laxative should be given, accompanied with tonics.

Influenza, also called pink eye, epizooty, bilious fever, etc., is a contagious disease which causes alterations in the blood, general depression of the vital forces and often inflammation of the lungs, intestines and brain. One attack ordinarily renders the animal immune to the disease. Influenza develops within from 5 to 7 days after exposure to the disease. The first symptoms are fever and a general dejected condition of the animal. The hair is rough and the animal has frequent chills. The fetlocks and under surface of the body may become excessively swollen. The temperature reaches the highest point within from 24 to 48 hours and remains nearly stationary for a period of 3 or 4 days. At the end of the course of the disease the fever abates rapidly and convalescence is prompt if no complications occur. The most common consequences of this disease are congestion of the lungs and pneumonia, inflammation of the brain, founder and pleurisy. Influenza is a very serious disease and the majority of horses are susceptible. It proves fatal in a large percentage of cases, especially in young animals, even with the best care, and about 50 per cent of the cases are complicated by diseases of the lungs.

Blood-letting has a favorable action in some cases, but is usually not to be recommended. As long as the appetite remains good, the animal should have a moderate quantity of sound, wholesome feed. The administration of quinine and salicylic acid in dram doses will lower the temperature, and aconite may have a favorable action upon the heart and circulation. Iodid of potash is sometimes administered on account of its alterative action and the indirect effect upon the lowering of the temperature. In cases where the action of the heart is much weakened, digitalis and other stimulants should be administered.

Strangles, also called distemper or colt-ill, is an infectious disease of horses, asses and mules, most frequently observed in young animals. One attack of the disease confers immunity. The first symptoms are sluggishness, irregularity of the appetite, increase in thirst, a dry coat and a bright rose color in the mucous membranes of the eye and mouth. After a period of about 2 days, there is a discharge from the nose which at first is watery and later becomes thicker and bluish in color. Soon after this discharge is established, a swelling takes place underneath the head between the jaw bones. The swelling is puffy and hot and results in the formation of an abscess, from which a discharge takes place. In some cases the swelling under the jaw is excessive and the abscess requires lancing. Delirium, plunging, and other involuntary movements are sometimes observed during the disease. Mild cases of strangles require little treatment beyond careful diet and protection from cold drafts. In cases where the fever is excessive, Glauber salts may be administered 3 times a day in large doses. Small doses of quinine, aconite or iodid of potash will assist in controlling the fever.

Botfly (*Gastrophilus equi*) in the adult condition is a fly about ¾ of an inch long, with transparent wings bearing dark spots. The body is hairy, the head brown, with a white front, and the body brown with 3 rows of black spots. The flies appear from June to October, and lay their eggs on horses in a position where the animal can reach them by biting or licking. The eggs are thus taken into the mouth and reach the stomach. Here the larvae hatch and attach themselves to the stomach walls by hooks. They remain in the stomach until they attain full size, when they become detached and passing out with the excrement complete their transformation into flies in the ground. The administration of medicinal substances to destroy or expel bots is usually unsatisfactory. Some experiments indicate that bisulphid of carbon administered in small doses in capsules has a beneficial effect in expelling the bots. Horses should be thoroughly groomed, in order to remove or destroy the eggs and prevent their entering into the stomach.

Screw Worm (*Compsomyia macellaria*) is somewhat larger than the common housefly, but resembles the latter in general appearance. (Fig. 377.) The color is metallic green, with 3 black stripes on the back. The eyes are reddish and are very prominent. Eggs are laid in wounds or the natural openings of animals or man, and the grubs after hatching bore their way into the flesh, making a deep wound. Infested animals if untreated may die of blood poisoning. The worms should be removed and the wound treated with a solution of corrosive sublimate, turpentine, kerosene or crude carbolic acid. Tar, grease or fish oil on wounds will assist in keeping the flies away. The screw worm fly attacks almost all domestic animals, but is perhaps most harmful to cattle, although its attacks upon horses are very important.

Bighead, also called osteoporosis, is a disease in which the bones become less compact by reason of an increase of the spaces filled with marrow and soft tissues. The enlargement of the head is usually the most conspicuous symptom and there are usually noticed a weakness in the back and a gradual change in the ribs, so that the horse becomes flat sided. Lameness appears suddenly and accompanies all the other processes of the disease. Horses, mules, and perhaps other animals are affected. Horses under 8 years of age are more susceptible than older ones. One attack of the disease does not confer immunity, but it is probable that an affected animal never recovers. Temporary improvement may be brought about in the animal's condition by rest and administration of lime in drinking water.

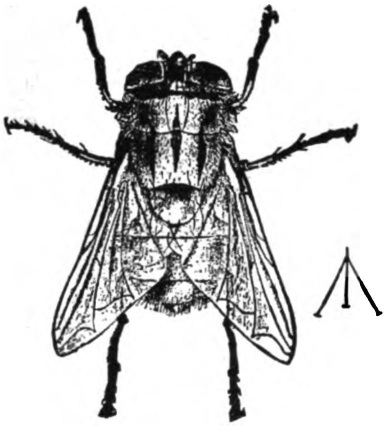


Fig. 377—THE SCREW WORM

Teeth of horses usually wear in an irregular manner by the constant grinding of their surfaces together, while the outer edge of the upper teeth and the inner edge of the lower teeth are not worn off at the same rate as the rest of the surface and project in the form of a cutting ridge. In such cases the sharp ridges may readily be felt by the hand and should be rasped off by means of a float, so as to prevent injuries to the cheeks and tongue. The indiscriminate floating and rasping of horses' teeth without definite reason is much to be deprecated.

Spasmodic Colic is the term applied to spasm of a portion of the small intestines. It is caused by copious drafts of cold water when the horse is warm, foreign bodies or indigestible food in the intestines. Other predisposing causes are usually assigned, such as the common observation that high-bred horses are more susceptible than coarse lymphatic animals. Spasmodic colic begins suddenly. The horses may look backward, stamp impatiently, paw the ground, suddenly lie down and get up again in a few moments. An interval of ease follows, but a sudden attack soon recurs, and as the disease progresses the attacks become more severe and the intervals between them shorter. When the pain becomes severe the animals throw themselves down and show convulsive movements which may result in serious injury. An effective remedy and one that is commonly used consists of 2 ounces of sulphuric ether and 2 ounces of laudanum in a half a pint of linseed oil. Another, and perhaps equally effective remedy, is 1 ounce of chloral hydrate given as a drench in solution in water. Indian hemp administered in the same way also gives good results.

Wind Colic is probably due to sudden changes of diet or to long periods of fasting, followed by a heavy feed. Indigestible or sour feed is also supposed to cause this affection. This form of colic does not develop so suddenly as spasmodic colic. The horse appears dull and an enlargement of the abdomen, difficult breathing, trembling and profuse perspiration are noted. A good remedy for this trouble is baking soda in doses of from 2 to 4 ounces. Chlorid of lime or carbonate of ammonia in ½-ounce doses every half hour usually gives relief. A cathartic should be administered when the symptoms are first manifested. Barbadoes aloes is perhaps the best for this purpose.

Roaring is a chronic affection which causes a loud peculiar noise in breathing. Roaring is caused by some obstruction in the air passages. The majority of cases of chronic roaring are due to paralysis of the muscles of the larynx, which is in turn supposed to be caused by nervous disease. Cases of long standing do not yield to medical treatment. If administered soon after the symptoms appear, a course of treatment with iodid of potash will give good results.

Heaves is a disease about which a great difference of opinion prevails. The general symptoms consist in a peculiar movement of the flanks during breathing and a chronic cough. In the act of expelling the air from the lungs, it is noticed that the elasticity of the lungs is considerably weakened, and that the abdominal muscles are brought into play to assist the action of the lungs. Respiration becomes, therefore, a double movement, partially interrupted before the contraction of the flanks takes place. Indigestion is nearly always observed in cases of heaves, and many veterinarians maintain that the cause of this disease is an affection of the pneumo-gastric nerve, which, as is well known, sends branches to the various vital organs. There is no satisfactory cure for long-standing cases. Proper regulation of the diet relieves the symptoms to some extent, and since the disease appears to be connected with digestive disturbances, especial attention should be devoted to the maintenance of a good ration. Some good effects have been noted from the use of arsenic in solution in hydrochloric acid. This solution may be obtained from any drug store and contains 4½ grains of arsenic in each ounce. A tablespoonful of this solution mixed with the feed 3 times daily, for a period of 2 weeks, prevents to some extent the development of the distressing symptoms of heaves.

Splints are bony enlargements which occur between the hock and fetlock joints on the inside of the leg. They vary considerably in size in different horses. They appear most commonly on the fore legs. Splints frequently accompany lameness which is not a continuous condition, but becomes more pronounced after considerable exercise. Since splints are comparatively harmless, it is not desirable to interfere with remedial methods, unless they become an actual cause of lameness. Tincture of iodin may be applied to the inflamed portions several times each day, and if this method is ineffective, resort may be had to Spanish fly blister.

Bone Spavin is an outgrowth of the hock joint. Enlargement usually appears on the front and inner side of the joint, but may sometimes occur on the upper part of the hock. In some cases there is no enlargement of the joint which may be detected by sight or touch. Such cases of spavin are due to a partial union of the bones which constitute the joint. This disease interferes in a very serious manner with the usefulness of the affected horse. Horses should be turned out to pasture at once and allowed to rest for not less than 1 month. Good results may be expected from local applications of astringents or liniments, such as iodin. Where such remedies fail to give the desired results, the part may be freely cauterized with a firing iron.

Founder or laminitis is an inflammation of the sensitive tissue of the feet, accompanied by general constitutional disturbances. As predisposing causes of this disease some writers assign plethoric condition, unusual excitement, and high calkings without corresponding toe pieces. The immediate causes of laminitis are usually blows upon the feet, overexertion, indigestible foods and the excessive use of purgatives. The first symptoms are congestion of the sensitive membranes of the foot, the pulse becomes accelerated, and the temperature rises. Respiration is also more rapid. The disease appears more often in the fore feet than in the hind ones. The acute cases run their course in from 10 days to 2 weeks or more, and the crisis in symptoms appears in from 3 to 5 days. Many complications have been noted as following upon attacks of laminitis. Among such complications mention may be made of spasm, sidebones, and sloughing of the sensitive membranes. For the purpose of preventing this disease, animals should be protected from cold drafts of air immediately after working. In simple cases of laminitis the feet should first be placed in warm water and after a period of half an hour be changed into cold water. The feet should be kept in a dish of water at a temperature of 45° to 50° F., or should be wet with cold water every half hour if the horse is lying down. Aconite may be given for 2 hours in 10-drop doses in cases where the pulse is rapid and strong. If in spite of all treatment excessive sloughing of the sensitive tissue of the feet takes place, it becomes necessary to destroy the animal, since cure of this condition cannot be effected.

Fistula is a term applied to the pipes or tubes leading from cavities in the muscles to the surface of the body through which a constant discharge takes place. The pipes are lined by a false membrane and do not heal. Fistulae may occur on any part of the body, but are most common in the withers and on the poll. In the latter situation fistula is commonly known as poll-evil. Fistulous withers and poll-evil are caused by blows or chafing from improperly fitting harness or saddle. The muscles at this point are so arranged that any pus that forms has a tendency to bury more deeply, rather than to make its way toward the surface, the result being a running sore in either case. If the trouble is noticed before the formation of pus has penetrated too deeply, the whole false membrane may be cut out by means of a sharp knife. In long standing cases, however, such operation requires too extensive cutting or might be dangerous. The treatment to be adopted in such cases consists in making an opening to the outside at a point slightly lower than the bottom of the pocket which contains pus. A free drainage to the outside is thus established and may be maintained by the use of a seton or string tied into the wound. The healing process may be facilitated by repeated washing of the cavity with rather strong solutions of antiseptic substances, such as corrosive sublimate or carbolic acid. Before making an incision into the bottom of the pus pocket, it is sometimes advisable to insert into the pocket through the upper natural opening of the fistula, a small quantity of blue vitriol or a stick of lunar caustic, for the purpose of destroying the false membranes which may have been formed. The incision into the bottom of the pocket may be made 24 hours later.

WOUNDS—The treatment of wounds in farm animals is a matter which receives little attention from the ordinary stock raiser. Various diseases, especially tetanus, may be contracted through fresh wounds, and there is always some danger of blood poisoning or septicaemia in such cases. The old notion that a healthy wound should discharge pus is a mistaken one. Where cut surfaces can be kept perfectly clean the wound heals without the formation of pus. Under ordinary circumstances this is impossible, in wounds in farm animals. Whenever an animal receives a wound, however, an effort should be made to treat the wound so as at least to prevent the development of dangerous bacteria. For this purpose corrosive sublimate may be used as a wash at the rate of 1 part in 1000 parts of water. A 2 per cent solution of lysol, formalin or creolin may be used in treating wounds. Carbolic acid, 1 part to 100 parts of water, is much employed for the same purpose.

Where wounds are so situated that they cannot conveniently be kept covered with gauze or cloth, the use of iodoform or other dry antiseptic substance is highly recommended. Iodoform is especially valuable on account of its power of driving away flies.

Since tetanus or blood poisoning often follows as a result of castration, it is highly desirable as a precautionary measure to dust the wound with iodoform or some similar antiseptic. Similar precautions should be taken when sheep are badly cut in shearing.

SARCOPTIC SCABIES or mange in horses has been known in several of the Western States for 20 years or more. It is believed to have been introduced into Montana by the Nez Perce Indians in their raid in 1877. Horses may be treated for this disease by spraying or brushing with zenoleum, chloronaphtholeum, or lime and sulphur dip. For applying these remedies it is necessary to rope range horses, and such application has already been made on many thousands of these horses.

MULE

Crosses or hybrids have been produced between the horse and all other members of the horse family, including the ass, the zebra and the quagga. Until quite recently, however, no great economic importance has attached to any of these crosses except the mule. The cross between the male zebra and the mare is known as zebroid, and the breeding of these crosses has been carried on in Brazil and elsewhere with considerable success. It is claimed that the size, form, pace and disposition of zebroids depend largely upon the mare, and therefore by the selection of heavy mares, such as Percherons, Suffolks or Clydesdales, large, strong zebroids are obtained, while if Arab and Norman are selected for breeding, the zebroids will be correspondingly tall and slender. It is claimed for these hybrids that they are capable of as much work as the common mule and are more graceful and docile.

The common mule is a cross between the male ass and the mare. The cross between the stallion and the female jackass is known as hinny. This cross is smaller and less desirable in every respect than the mule. It has never attained much economic importance.

Various breeds of jacks are known and used for the purpose of breeding mules in this and other countries. The Catalonian is a fine type, with black color and good action. The hight is usually from 14½ to 15 hands. The Andalusian is of the same type, but perhaps heavier, and usually with less desirable colors. The Majorca is the heaviest of the imported jacks and frequently attains a hight of 16 hands. This breed is rather deficient in style and action. The Maltese is small, being rarely over 14½ hands, but possesses a smooth coat. The Italian is the smallest of imported jacks, standing usually from 13 to 14 hands high. The Poitou jack is supposed to be of Spanish origin and is much used for breeding purposes in France. It has been introduced into the United States but is not as well known as other breeds. It is distinguished by its enormous head, ears and legs. The native jack is as a rule heavier and larger boned than the imported species. It is presumably the result of a mixture of all the imported breeds and possesses all of the colors belonging to these breeds. As a rule mule breeders in this country prefer native jacks to all of the imported breeds. The colts obtained from native jacks are stronger and with more length. The size and color of native jacks in this country vary exceedingly, according to the mixture of breeds from which they have descended and the care in selection which has been exercised by breeders. A typical native mule is seen in Fig. 378. In the Western States the common form of jack in the mountainous regions is known as burro, and this breed is presumably descended from stock originally brought into the country by Spanish settlers of that region. This animal varies in color from white to almost black and varies also considerably in size, and especially in the thickness of the base of the neck.

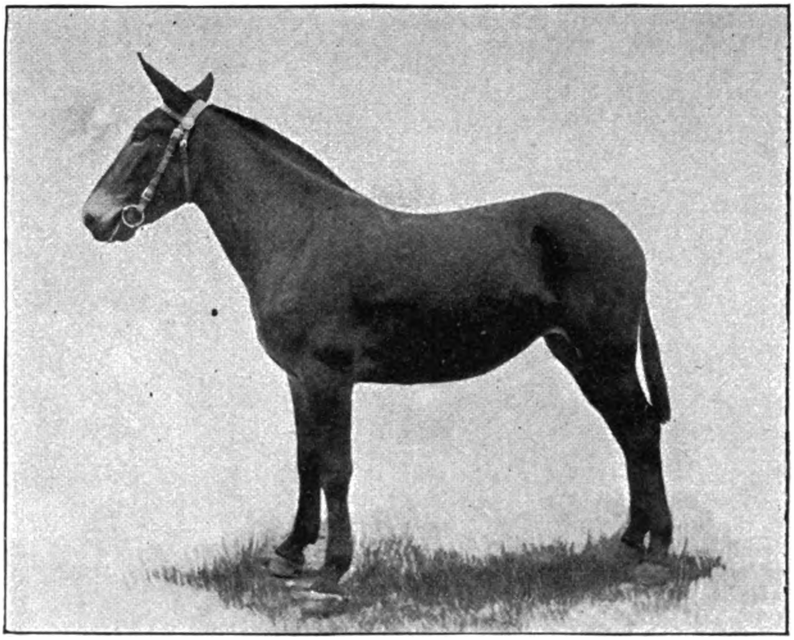


Fig. 378—TWO-YEAR-OLD MULE

The mule industry in the United States is of great importance and has received especial impetus during recent years on account of the Spanish-American and South African wars. The States in which the largest numbers are bred are Missouri, Texas, Tennessee, Kentucky, Arkansas, Kansas, and in general the Southern and Central States. According to the latest census there are at present 3,285,000 mules and 105,000 jacks and burros in the United States. The market prices of mules are uniformly higher than those for horses, and as a result of these conditions the raising of mules under favorable conditions is a very profitable industry. Mules may be used for all purposes for which horses are suited, and in addition are well adapted to several lines of work in which horses cannot be employed. Mules excel horses in their capacity for hard labor, in endurance, in length of life, in freedom from disease and in economy of feeding. In an emergency mules may be worked for 24 hours or more without water and for 2 or 3 days without feed. The injurious results of such treatment are much less serious than in the case of horses. Digestive disturbances are less frequent in mules than in horses, and in general, with the possible exception of glanders, mules are comparatively less subject to disease than horses. Mules are especially adapted for use in mining, and as beasts of burden for packing purposes. For the latter purpose, also, the jack and Western burro are especially adapted; these animals, though diminutive in size as compared with the horse, will carry as much weight, and as far in a day, as horses. They are, moreover, sure footed, and can carry packs with safety where accidents would be almost inevitable with horses. The economy of feeding mules makes their employment in sugar and cotton raising almost universal; in fact, it may be doubted, under present conditions, whether these industries would be possible if all the labor which is now done by mules had to be performed by horses. In the Southern States 2 types of mules have received special names on account of their connection with these industries. The sugar mule is larger, more powerful and more valuable than the cotton mule, which is the smaller, cheaper type. These types are governed according to the requirements placed upon the animal, the work in the sugar field being harder than that in the cotton field.

As draft animals and for general work purposes mules excel horses in several respects. They are capable of more continuous application at heavy work, under unfavorable conditions. Although they may often be less tractable, they are also less excitable and therefore more desirable for work in situations where unsteady movements or plunging would be dangerous to the draft animals and to the machinery and attendants. The color which is most desired in mules is dark brown or black, and in breeding them the jacks and the mares are selected with reference to the probability of securing these colors in the mules. It is usually considered that the female mule is more desirable than the male.

Mules require essentially the same general care and management as horses. They should be weaned at about 4 months of age, and the subsequent feeding should be governed according to the purpose for which the mules are being raised. The market requirements for mules are that they shall be fat, and attention should therefore be given to this point in order to bring them to a fat condition soon after they are 2 years of age. In the Southern States it is well to begin the fattening process in November before the animals become 2 years old. They may be fed a dozen ears of corn per day and an abundance of clover or timothy hay, until the following April. The mules may then be turned out upon clover pasture and the quantity of grain may be increased. As soon as the clover is cut feeding with clover hay may be resumed in the barn, and shelled corn should be continued in the ration. When barley is harvested it should be ground coarsely and fed in fresh condition, taking care that it does not sour. At this time the ears of early corn may be fed, while a highly nutritious diet should be continued, consisting of corn in the ear, shelled corn, ground barley, oats and bran. The animals should have free access to water and salt. Shelled oats and bran are regarded by many mule raisers as essential to the proper finishing of mules for market. With sugar mules this process of feeding should bring the animals to a weight of from 1200 to 1350 pounds when they are just past 2 years of age. The same care and attention should be given to the feeding of cotton mules, except that the process should begin later, usually after the animals are past the second year.

Experiments have shown that ground Kafir corn and Kafir corn stover constitute an excellent feed for mules. In one experiment mules were kept in good condition by feeding on Kafir corn stover for about 6 months, and on alfalfa and prairie hay for the remainder of the year. In comparative experiments with mules and horses it was found that the mules did about 1-3 more work than the horses, ate less corn, more stover and required more water. Bermuda grass hay and timothy are of about equal value in feeding mules. It is stated by J. L. Jones that as the result of experiments extending over a period of 25 years, 3 mules may be expected to consume about as much feed as 2 horses, and to remain in better condition than the horses, although doing the same amount of work. For further details on feeding see under *Horses.*

SWINE

Swine in the United States are grown primarily for pork and lard and there is no fixed market for any other type. In Canada bacon hogs are grown to a considerable extent for the English market, the Tamworth breed being chiefly used for this purpose. Some of the long-bodied breeds grown in this country are also used in the production of bacon, but they are first of all lard hogs. Some of the chief characteristics of the principal breeds of hogs grown in the United States may be briefly mentioned as follows:

Berkshire—The Berkshire (Fig. 379) is a black hog with white feet, white line in the face and white splash on the end of the tail, with occasional white spots on other portions of the body. Ears erect. The sows are prolific and active. Good shoats weigh 240 to 300 pounds at 9 to 12 months of age and mature hogs 500 to 650. They are fine boned and on this account more subject to broken legs in shipping than the larger boned breeds. A very popular breed in the South.

Poland-China — The Poland-Chinas (Fig. 380) are black and white spotted hogs weighing 250 pounds and upward at 9 to 12 months and 600 to 700 pounds when mature. They have large hams, short, strong legs, are excellent shippers and the most generally popular breed grown by Western farmers.

Duroc-Jersey — The Duroc-Jersey (Fig. 381) is a red-haired hog. Otherwise they much resemble the Poland-Chinas. Well-matured shoats weigh 250 to 340 pounds when 9 to 12 months old and 400 to 700 pounds at maturity. They are quiet hogs, excellent feeders, stand forcing well and never sunscald. The bones are large and the sows very prolific.

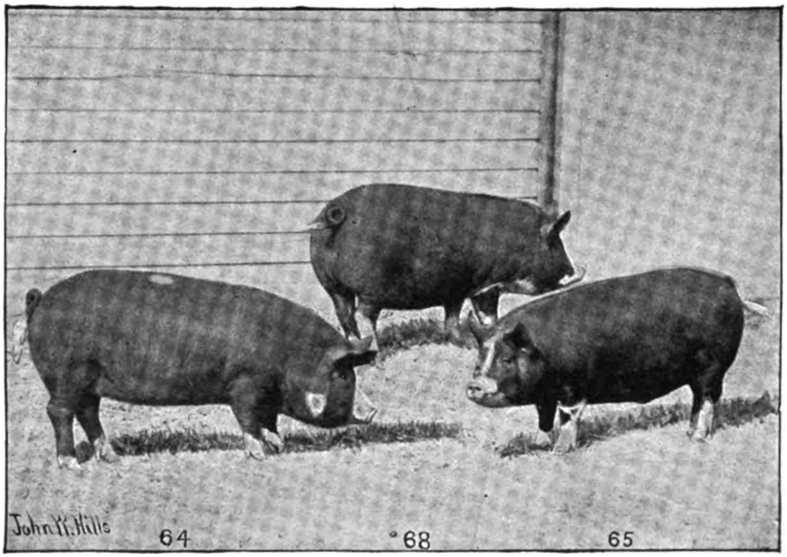


Fig. 379—BERKSHIRE SWINE
(From Iowa Expt. Sta. Bul. 48)

Chester Whites (Fig. 382) and Todd's Improved Chester Whites are both white breeds. The hogs dress 175 to 250 pounds when 8 to 9 months old and weigh when mature 600 to 700 pounds. They sunscald easily in the South, but are popular breeds farther north and in the East. The sows are prolific, but apt to be cross at pigging time.

Victorias—The Victorias (Fig. 383) are made up of 2 distinct breeds, the Davis and the Curtis. Both are white hogs with erect ears and weigh 300 to 400 pounds when 10 to 12 months old. It is claimed for the Davis Victorias that they are but little subject to mange and sunscald in the South. The sows are prolific and good mothers.

Cheshire hogs (Fig. 384) are white with small, erect ears. They have long, broad, deep bodies, broad hams and nearly straight back. At maturity they will dress from 400 to 600 pounds if well fattened.

Yorkshire—The small Yorkshires (Fig. 385) are pure white hogs with pink skin; ears erect. These hogs will weigh when mature 375 to 450 pounds. They have a short, rounded, deep body, well covered with hair, and will do as well in the South as any of the white breeds; but cannot compete with the black-haired hogs.

"Razor Backs"—The "razor back" is a lank-bodied, long-nosed, nondescript hog, representative of the unimproved breeds. He is scarcely known in this country outside of the Southern States, and has no place in modern agriculture.

Tests of Breeds—In the station experiments with breeds, better results in gains have been made with pure breeds in Iowa, Kansas and Utah than with scrubs. At the Ottawa Station cross bred and grade hogs made better gains than pure breeds. At the New York State Station the most profitable gains were made with a Yorkshire-Tamworth cross. The Berkshires have made 100 pounds of gain with less feed at 5 stations than any other breed tested. At 2 other stations they were surpassed by a number of breeds. At the Ottawa Station a Tamworth-Berkshire cross made leaner, better meat than pure Berkshires. The Tamworth and Yorkshire are the breeds most prized for bacon by the Ontario Station. In tests at the Maine Station no constant differences occurred in the feeding or market qualities of the different breeds. The Iowa Station has shown that the Tamworth furnishes a carcass most in demand by the British market, followed by Berkshires, Duroc-Jerseys, Chester Whites, Poland-Chinas and Yorkshires, mentioned in the decreasing order of their desirability.

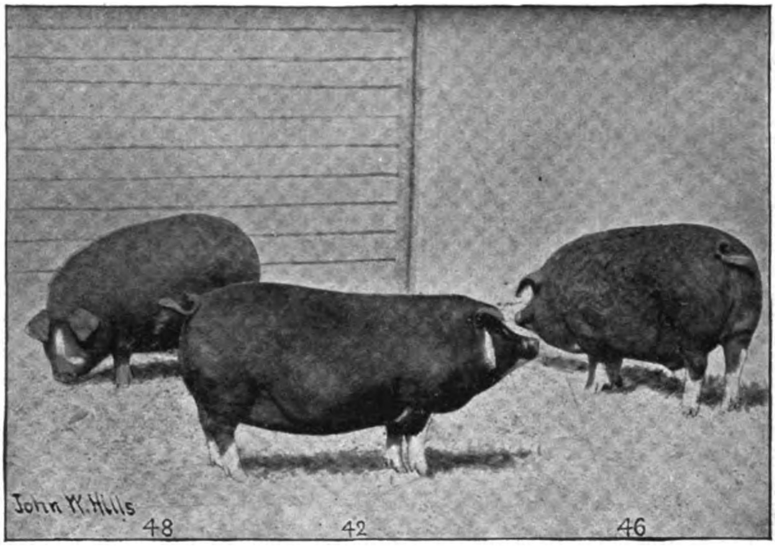


Fig. 380—POLAND-CHINA SWINE
(From Iowa Expt. Sta. Bul. 48)

Essex—The Essex (Fig. 386) is another small to medium-sized hog. It is a black hog with compact body and weighs 250 to 400 pounds at maturity. It fattens readily, is not affected by sunscald and is especially valuable in the South. Where corn is abundant the Essex cannot compete with the larger breeds.

Suffolk—The White Suffolk resembles the small Yorkshire breed, but is perhaps a little larger.

Tamworth—The Tamworth (Fig. 387) is not yet grown to any considerable extent in the United States. They are long-bodied hogs and when grown for bacon are usually sold when they weigh 160 to 225 pounds at 6 to 9 months of age.

Best Breeds to Raise—The station experiments as a whole indicate that there are no constant differences in the feeding qualities of the various breeds of hogs now grown in the United States. Other things being equal, it is probable that the best breeds of pigs for the American farmer to grow are the largest ones. Nothing has been more clearly demonstrated in the station experiments than that pigs increase in weight most rapidly, require less food to make a pound of gain and make gains most cheaply during the early stages of growth. As pigs approach maturity it costs 3 to 4 times as much to make a pound of gain as in the earlier stages of growth. Hogs most in demand in the great packing centers are those weighing from 225 to 325 pounds each when 8 to 14 months old. If breeds of hogs weighing 500 to 800 pounds when mature are selected and these marketed when they have reached weights of 200 to 300 pounds, the chances are that the grower has produced his pork at the most economical figures. Management and feed are more important than any particular breed.

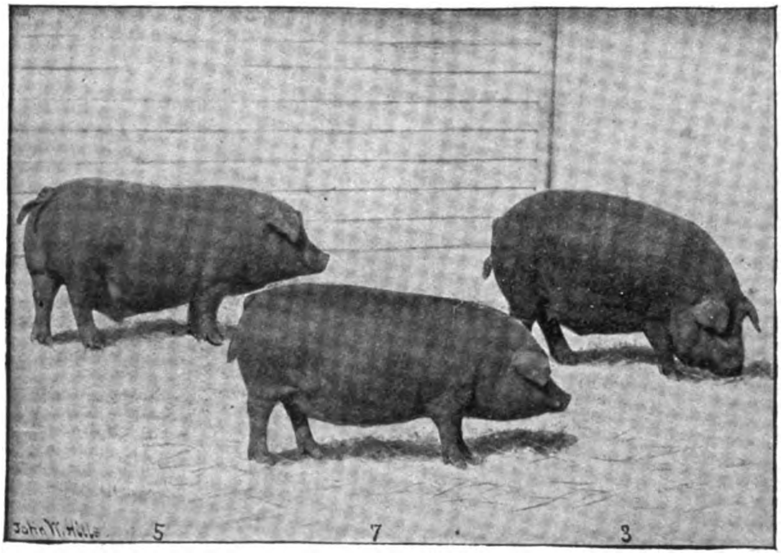


Fig. 381—DUROC-JERSEY SWINE
(From Iowa Expt. Sta. Bul. 48)

Boar and His Management—The boar is generally considered half the herd. He should contain the best characteristics of the breed to which he belongs. He should have a strong constitution, good feeding capacity, relatively short neck and short legs, since these indicate good fattening qualities, and a close, compactly built body. Good boars for pork producing purposes can usually be purchased when 4 months old for $8 to $20. Of course boars for fancy breeding purposes, where color, form and markings must conform closely to the ideal, will cost much more than this. But good breeders frequently sell boars slightly off in markings at little more than their pork value. Such animals may often be used very profitably where pork and not show is wanted. The boar should be kept in a lot by himself and be given plenty of good clover or like kind of pasture and such other foods as middlings, oats, peas, bran, etc. He should not be fed so heavily as to become fat and unwieldy. Boars give their best service when 2 to 5 years old; but boars 8 to 9 months old may be satisfactorily used for breeding old sows.

Sow and Her Management—Young sows or sows in poor condition carry their pigs about 16 weeks and old sows 1 to 2 weeks longer. With 8 breeds at the Wisconsin Station the litters ranged from 6 to 10 pigs each and weighed from 13.5 to 22.5 pounds. The pigs at birth weighed from 1.3 to 3.1 pounds each. Analyses at the same station of different samples of sows' milk showed an average of 8.24 per cent fat, 6.04 per cent casein and albuminoids, 4.75 per cent milk sugar and 1.07 per cent ash. The quantity yielded varied from 4.1 to 5.8 pounds per day and in one instance reached 8.7 pounds.

Sows should not be bred before they are 8 months old. They should be allowed to suckle their pigs from 2 months to 10 weeks and be so managed as to produce 2 litters a year. Good breeding sows should be kept as long as they produce large litters and prove good mothers. This is usually 4 to 5 years. When they fail in either of these respects they should be fattened for meat.

Pregnant sows should be allowed to run in a lot containing plenty of green feed. They require in addition such liberal allowances of such muscle, bone and milk making foods as shorts, ground peas and oats, bran, etc., as will keep them in good condition. Corn is fattening and is not suitable for pregnant sows except in small amounts when fed with milk or such grains as noted above. About a week before farrowing the sow should be separated from the other hogs and put in a pen by herself with a very small amount of bedding. The pen should have a 10 or 12-inch plank running around the sides of it 6 to 8 inches above the floor as a protection for the young pigs so that the sow cannot crush or smother them. A constant supply of ashes and salt should be kept within reach of the sow and should she appear costive at this time she should be given a good feed of wheat bran. At farrowing time she should be fed nothing but water or thin slop for the first 24 hours and only very lightly for several days. At the end of a week the ration should be rapidly increased and should consist of such milk producing foods as shorts, bran, ground peas, milk, etc. From now on while the sow is giving suck to her pigs, she should be fed heavily. The Wisconsin Station found it profitable to feed suckling sows so heavily that they gained in weight. The gain thus produced in the young pigs indirectly through the sow, was cheap and more economical than later gains. When the young pigs are 2 or 3 weeks old they will begin to take food given them from a separate trough made but 3 or 4 inches deep. Skimmilk or a thin porridge of middlings is most relished at this time. As soon as they begin to eat freely they should be crowded with feed, since the most economical gains in the life of the pigs are made at this time. At the Wisconsin Station sows and pigs before weaning required 316 pounds of corn meal to make 100 pounds of gain, while the pigs alone after weaning required 384 pounds of meal for 100 pounds of gain. At the Michigan Station, on the contrary, it cost a little more to put growth on pigs before weaning than afterward.

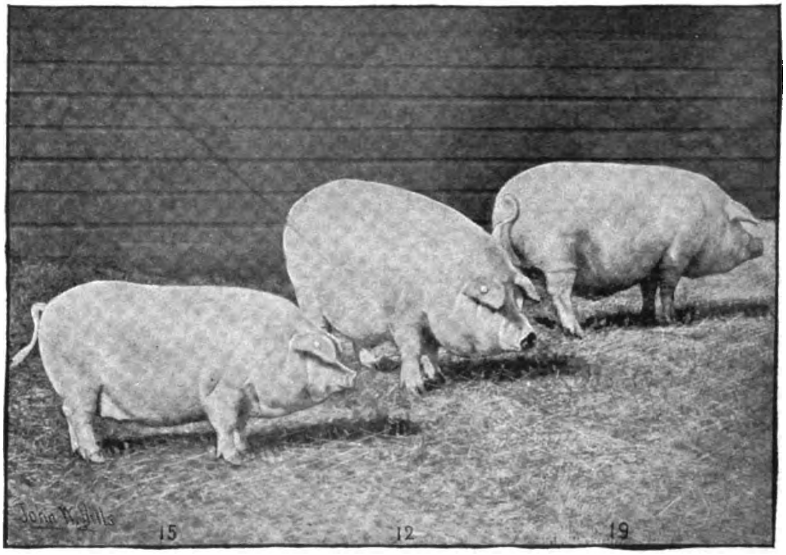


Fig. 382—CHESTER WHITE SWINE
(From Iowa Expt. Sta. Bul. 48)

When the young pigs are about a month or 6 weeks old all the males intended for pork should be castrated. If this operation is done while the pigs are still sucking the sow there will be practically no check in growth; if it is neglected then the operation should be postponed for a month after weaning, or until they become accustomed to eating solid food. After weaning the sow will come into heat again in 2 or 3 weeks and should be bred again. In one test at the Kansas Station gains were cheaper and greater in offspring of mature sows; in another test no difference was noted.

Pasturing Hogs—Young growing pigs should have plenty of green pasture, pure water and grain. The old method of allowing pigs to grow for a year on pasture or in wood lots without other feed is expensive and not now practiced by those who make a success in growing

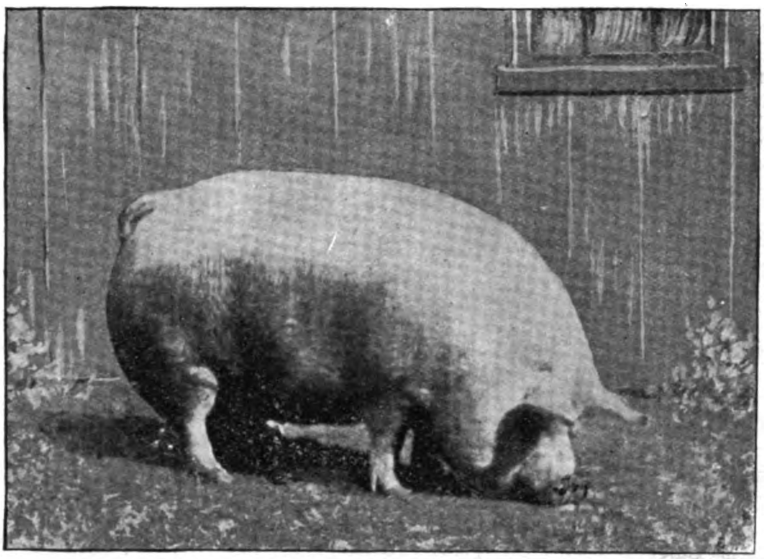


Fig. 383—TYPICAL VICTORIA SOW

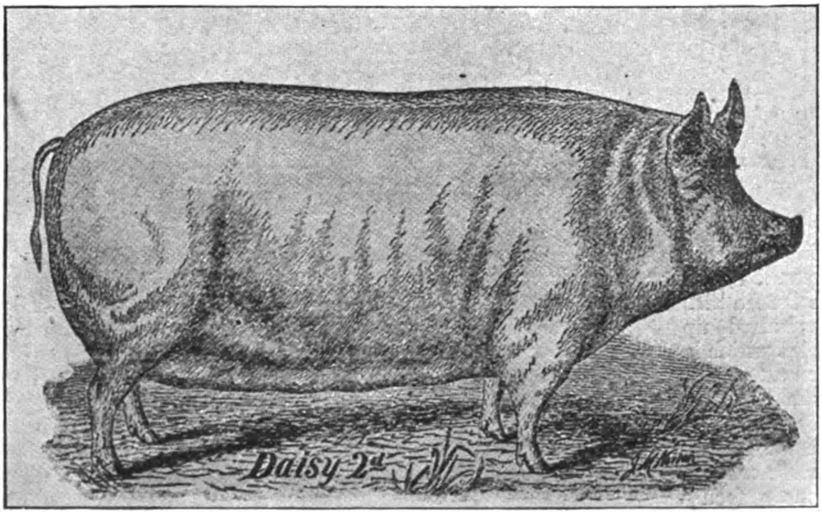


Fig. 384—CHESHIRE SOW

hogs for pork. Pigs should be so fed as to gain in weight from ½ pound to a pound a day from the time they are 3 weeks old until they are marketed. On pasture alone hogs make too slow gains for profit and cannot be brought to a marketable condition. Pigs at pasture, however, make the best use of the grain fed to them, as shown by experiments at a number of stations. On a full grain ration pigs at pasture made 33 per cent better gains at the Utah Station than pigs without green feed. Cutting the green feed and feeding it to pigs in confinement did not give as satisfactory results as pasturing. At the Maryland Station there was more profit from pigs running in pasture or woods in summer and penned up for fattening 8 to 10 weeks before killing time than from pigs kept penned up during the summer. The pigs which had been at pasture made faster and cheaper gains, were more vigorous and had better appetites than those kept penned up. In Ontario firmer bacon was produced with exercise than in close confinement. At the Utah Station more feed was consumed and the gains were more rapid with pigs given exercise than with those kept in close confinement.

Some of the best green feeds for hogs are alfalfa, clover, rape, cowpeas, peanuts, artichokes and sweet potatoes. Hogs are wasteful grazers and the fields of pasture crops should be arranged with movable fences in such a manner that the hogs can pasture only on a small portion at a time. A succession of crops should be grown so that the hogs will have continuous pasture throughout the season.

The Arkansas Station recommends red clover, sorghum and peanuts as the best succession for grazing hogs in that State. Alfalfa may replace the red clover. Hogs grazed on these crops made rapid and economic gains on small grain rations. Oats and rye were not profitable for a hog pasture at this station.

At the Kansas Station 1 acre of alfalfa pasture produced 776 pounds of pork. Alfalfa proved inferior to sugar beets at the Montana Station but saved grain as a part ration.

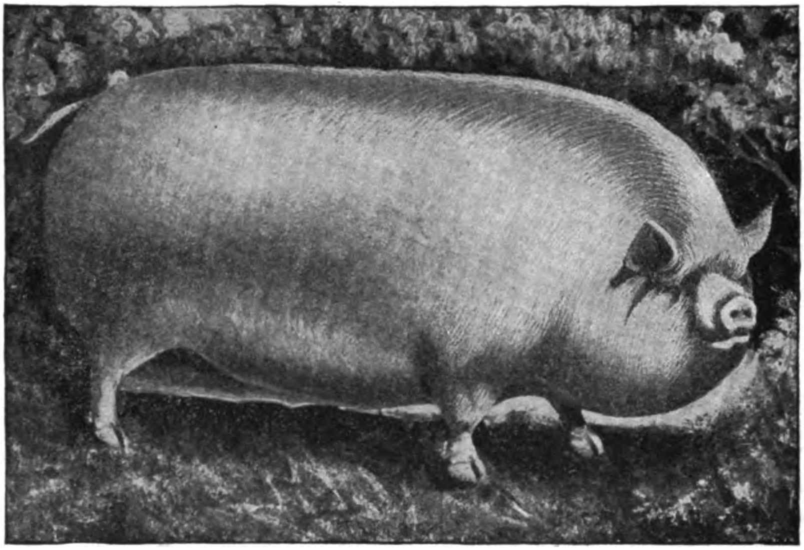


Fig. 385—TYPICAL SMALL YORKSHIRE SOW

Brome Grass pasture was greatly relished by hogs and gave good returns at the Ottawa Station.

Dwarf Essex Rape grown in the same manner as for sheep (see *Rape*) has proved an especially valuable crop for pasturing hogs at the Wisconsin Station and has also given good results when cut and fed green. The rape was greatly relished by hogs after they learned to eat it, but was not sufficient as an exclusive ration. In one experiment at the Wisconsin Station 1 acre of rape proved equal in feeding value to 3318 pounds of grain (corn and shorts), in another test to 2767 pounds, and in a third test to 2436 pounds. This crop is considered the best green feed tried at that station for pigs 4 to 10 months old. It saved 33 pounds more grain per 100 pounds of gain than clover and the pigs fattened on it were thriftier and had better appetites than when fed grain alone. The crop does not cause bloating or scouring if properly fed. A view of pigs pasturing in a rape field at the Wisconsin Station is seen in Fig. 388. Indifferent results were secured with rape in pig feeding experiments at the Utah and Indiana Stations.

SORGHUM and KAFIR CORN are among the best green crops for early summer grazing for the Southern and Western States, and if planted at intervals will furnish forage until late fall. The sorghum may be grazed as soon as it has reached 5 or 6 inches in hight. The Kafir corn is of more value later in the fall after the heads have matured. Cowpeas furnish valuable forage from July to September in the North and still later farther south. Chufas are grown to some extent for hogs. At the Arkansas Station firm, fat pork was produced on chufas, but it was not equal to that produced from corn. At the Alabama Station an acre of chufas produced about 374 pounds of pork and were fully equal to Spanish peanuts as a pasture for hogs. Purslane is often fed to hogs. They made fair gains on this plant when fed in connection with a grain ration at the rate of 9 pounds per day, but did not greatly relish it.

ARTICHOKES are excellent as a green feed for hogs in early spring and late fall and are greatly relished by them. The hogs root out the tubers themselves. At the Ottawa Station pigs on artichokes made rapid gains when given only a small grain ration (1½ pounds mixed meal per day). Both the Arkansas and Maryland Stations have found artichokes profitable in pig raising. At the Indiana Station they did not prove profitable for hogs. In Missouri 1 bushel of artichokes and 3 bushels of corn proved superior to 4 bushels of corn for hogs, and very similar results are reported from the Oregon Station. For the culture of artichokes see *Artichokes.*

SWEET POTATOES make a good root crop for hogs in the South, especially on light soils. They may be had from September to November and the hogs do their own harvesting. At the South Carolina Station it required 32½ pounds of sweet potatoes to make 1 pound of gain. In Arkansas hogs in a field of sweet potatoes at the station did not take to them readily and did not make satisfactory gains. The Alabama College Station found 3 pounds of sweet potatoes inferior to a pound of corn meal for hogs. The crop was of considerable value at the Maryland Station when fed in connection with gluten meal and milk. Like other succulent food, sweet potatoes, to be of value for hogs, must be fed in connection with a grain ration.

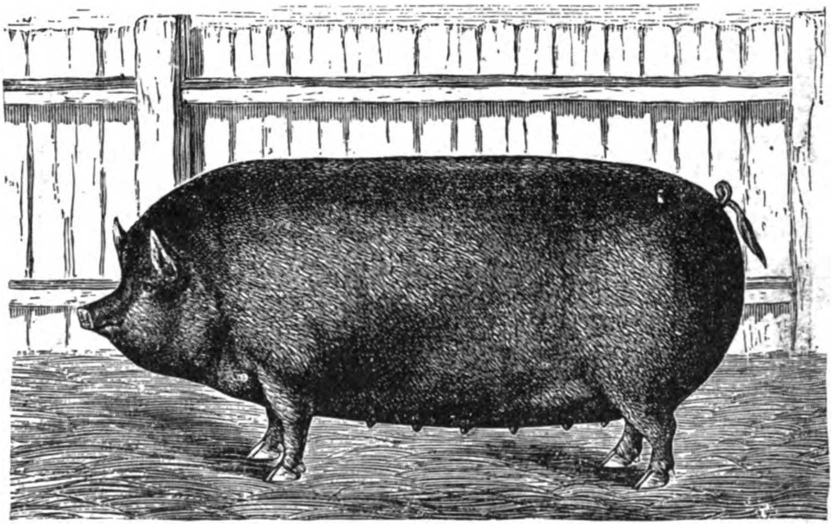


Fig. 386—ESSEX SOW

Early Feeding—Hogs never make such rapid and economical gains as when they are young. Feeding with skimmilk, kitchen slops and grain should therefore commence as soon as the pigs can be induced to eat these different foods and continued until the pigs are marketed. At first the more nitrogenous foods like skimmilk, shorts, ground oats, ground peas and barley should be fed, and later more carbonaceous rations given. Feeding in early life should be for the purpose of developing the bones, muscles and vital organs of the pigs. This gives a foundation for more profitable forcing later. In feeding experiments at the Utah Station young hogs on grain alone made poor use of their food. Much better results were obtained when milk was added. Some corn may be fed to growing hogs on pasture, providing they have an abundant supply of other nitrogenous foods or access to wood ashes, bone meal and salt.

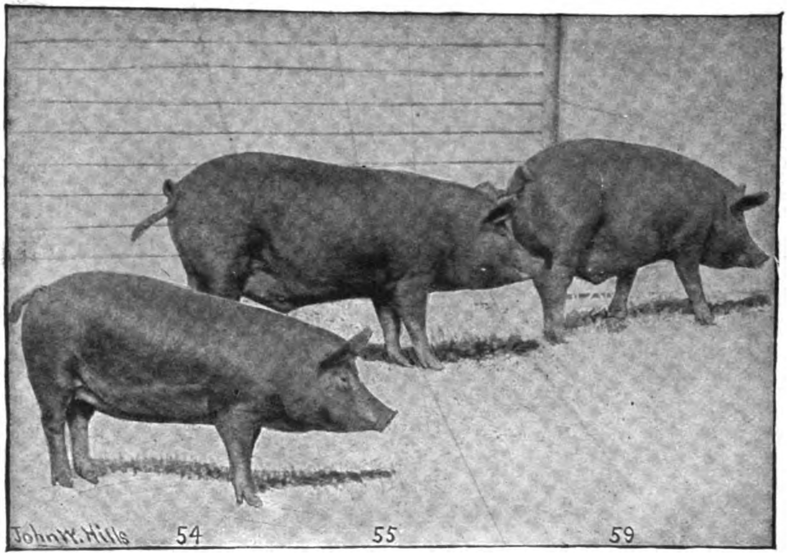


Fig. 387—TAMWORTH SWINE
(From Iowa Expt. Sta. Bul. 48)

Ashes and Salt for Pigs—An abundant supply of wood ashes and salt, to which the hogs can have constant access, is an essential in hog raising and should never be neglected. In experiments at the Wisconsin Station when either hard wood ashes or bone meal was fed to hogs the strength of the bones was about doubled and there was a saving of 28 per cent in the amount of food required to make a pound of gain. The addition of the bone meal or wood ashes to the daily ration caused the consumption of more salt, water and corn meal. Either charcoal or ground bone may be substituted for wood ashes. Hogs are never injured by eating all the ashes they want and they are especially necessary when highly carbonaceous rations like corn are fed. In experiments at the New York State Station better gains were made on all rations when a small amount of salt was added. Large quantities of salt should not be fed since they may reduce the gains. The salt and good hard wood ashes should be mixed in about the proportion of 2 quarts of salt to a bushel of ashes. Sometimes a few ounces of copperas are added to this mixture, which acts as a kind of tonic. This mixture should be kept in a low box under shelter to which the hogs have access at all times. Brood sows which have an abundance of such material with their daily rations seldom eat their young.

Sows vs. Barrows for Fattening—At the Utah Station where this matter was tested about the same gains were made by both. The gains made by the sows were slightly greater. In Denmark no constant difference was found in the fattening qualities of sows and barrows. Unspayed sows at the Utah Station made slightly better gains than spayed sows. At the Indiana Station the periods of heat (oestrum) in the sow had no apparent effect on gains.

Shelter for Hogs—Comfortable sleeping quarters should be provided for hogs and shelter from the scorching sun, cold rains and snow. The sheds need not be expensive. Hogs required more feed for maintenance when fed in the open air at the Utah Station, but made more economical gains.

Hogs Following Steers—When steers are fattened for market a considerable percentage of the grain given them, especially if unground, passes through the intestines undigested. Experiments at several stations and the general practice of feeders show that hogs following steers require much less feed to make a pound of gain than otherwise. Hogs made good gains on corn obtained in the droppings of corn-fed steers at the Wisconsin Station, and it is recommended that steers be fed unhusked shock corn and hogs be allowed to run with them. Hogs did better when the steers were fed dry corn than when fed soaked corn. When cattle were fed corn meal at the Iowa Station hogs made little gains following them. Hogs at the Kansas Station made equally good gains on manure of steers fed on Kafir corn. They also profitably followed cattle that were fed on cottonseed meal, but at the Iowa Station where hogs followed cattle which had been fed cottonseed meal for 17 weeks harmful results followed.

Cooked vs. Uncooked Feed—At the Wisconsin Station hogs made cheaper gains on uncooked corn and shorts than on cooked. The cooked corn was not properly masticated. A considerable loss was noted in the feeding value of barley meal, corn meal and shorts by cooking. In the station tests 439 pounds of uncooked corn meal equaled 454 pounds of cooked meal. On rations of peas, barley and rye the Ottawa Station found a slight advantage in favor of steaming, but not enough to pay for the extra labor. In German experiments uncooked corn meal has given better results than cooked corn meal. All these experiments tend to show that it is not necessary or advantageous to cook feeds for hogs. These remarks do not apply to roots, more especially potatoes, as will be shown in the remarks on feeding stuffs for hogs beyond. At the Ottawa Station cooked roots have given better results with hogs than raw roots.

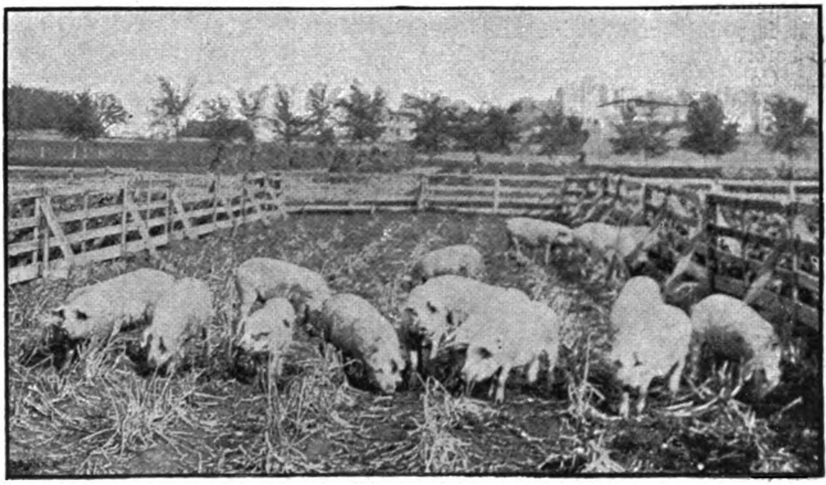


Fig. 388—PIGS HURDLED ON RAPE AT THE WISCONSIN EXPERIMENT STATION

Whole vs. Ground Grain—Experiments at the Vermont and Wisconsin Stations indicate that strong, vigorous hogs do not require that corn be ground. It may be ground and fed in the later stages of the fattening period, especially with hogs not in the most vigorous condition. In some cases there is an apparent loss in the feeding value from grinding. Pigs eat more corn meal than whole corn and therefore usually make more rapid gains, but experiments at the New Hampshire, Vermont, Wisconsin, West Virginia and Colorado Stations show that the increased gains are not sufficient to pay for the extra cost of grinding. At the Wisconsin Station 8 per cent better gains were made on corn meal than on whole corn. At the New York State Station 16 per cent cheaper gains were made on corn meal than on whole corn. In West Virginia 472.9 pounds of corn meal equaled 506 pounds of whole corn for hogs. Whole corn has proved equal or superior to corn meal for pigs at the Maine and Kentucky Stations. As a general thing, unless a mill for grinding is convenient and the corn is very dry and hard it will not pay to grind it for hogs. With whole peas, barley and rye at the Ottawa Station it required 4.45 pounds of mixed feed to produce 1 pound of gain and 4.36 pounds when these grains were ground. In later experiments it required 4.08 pounds of whole grain and 3.56 pounds of ground grain to make a pound of gain. Frozen wheat also gave somewhat better gains when ground. The station concludes that it is profitable to grind and soak grain before feeding. In feeding barley at the Colorado Station better results were secured with ground corn, bald and common barley than with whole grains. It paid to grind the bald barley but not the common barley or corn. At the Alabama Canebrake Station firmer meat and more rapid gains were made on corn meal than on whole corn. In Holland cracked corn has been found superior to steamed whole corn.

Wet vs. Dry Feed—The data reported by the experiment stations on this subject are somewhat conflicting, but in general they tend to show that soaking has about the same effect on grains as grinding and is desirable. At the Illinois Station pigs ate more and gained more on soaked corn than on dry corn. The Ottawa Station recommends soaking all grains, whether ground or whole, for 24 to 30 hours before feeding. At the Wisconsin Station hogs ate more and did better on wet than on dry feed. Wet corn meal was more satisfactory for feeding to pigs at the Vermont Station than dry meal. In West Virginia 385 pounds of soaked corn equaled 410 pounds of dry corn meal. At the Ontario Station dry and wet mixed meal was of equal feeding value, but more of the meal was wasted when fed dry than when fed wet. With bran, corn meal and wheat more rapid gains were made at the Utah Station when these feeds were fed dry; but cheaper gains were made when they were fed wet. At the North Carolina Station sloppy feed gave poorer results than feed barely moistened, but dry grain gave better results than either. In Indiana slightly better results were obtained by feeding dry grains with twice their weight of water to drink. At the New York State Station there was no difference in the gains made on wet and dry feed. In experiments at the Minnesota Station pigs ate more wet feed than dry, but it was no more effective in producing gain. In some German experiments rye and barley meal were found more effective dry than wet. The weight of evidence seems to be that it is desirable and advantageous to soak grains for hogs, but not to cook them. The advantage of soaking on the whole appears to be about 7 or 8 per cent.

Relation Between Weight of Hogs, Gain Made and Food Required—We have already spoken of the more profitable gains made by feeding young, growing pigs. The following table brings this matter out more clearly. It is based on Professor Henry's table in "Feeds and Feeding." This has been revised to include the results of all experiment station work in this country reported up to June, 1902. The figures are based on so many experiments and animals that they may be considered very reliable and made the basis of calculation in estimating the cash and profits in hog raising so far as feeding stuffs are concerned.

RELATION BETWEEN WEIGHT OF HOGS, GAINS MADE, AND FOOD REQUIRED

Weight of pigs, lbs.	Average weight, lbs.	Number of States reporting	Number of trials	Number of animals fed	Average feed eaten per day, lbs.	Feed eaten daily per 100 lbs. live weight, lbs.	Average gain per day, lbs.	Feed required to make 100 lbs. gain, lbs.
15- 50	39	10	45	190	2.41	5.82	.78	305
50-100	79	21	112	508	3.62	4.58	.94	402
100-150	123	19	133	635	5.03	3.96	1.20	439
150-200	178	13	110	509	5.98	3.44	1.26	479
200-250	227	13	76	316	6.60	2.96	1.35	493
250-300	269	10	51	247	7.34	2.71	1.48	509
300-350	322	4	21	115	7.54	2.39	1.47	532

The last column of this table brings the fact out clearly that it requires about two-thirds more food to produce 100 pounds of gain with hogs weighing about 300 pounds than with hogs weighing 40 pounds, and that there is a uniform increase in the amount of food required to produce a pound of gain as the pigs increase in weight. Experiments at the Wisconsin Station show that a maintenance ration for hogs amounts to about 1 per cent of the live weight of the animals when middlings are fed. Small pigs require relatively smaller amounts of feed for maintenance than large hogs.

Grains and By-Products for Fattening Pigs—Under this heading the value of the different grains, mill products, tankage, sugar and like feeds used in producing pork, will be noted alphabetically.

ACORNS—Hogs are often fall pastured in oak woods on acorns. At the Tuskeegee Agricultural School in Alabama, acorns gave a desirable flavor to the meat. The meat produced was soft and did not harden readily except when corn was fed with it. The acorns had a tendency to produce constipation. Acorns may be successfully kept in large quantities by collecting and placing in cool, well-ventilated barrels.

BARLEY—This grain is especially valuable for growing hogs and in the production of firm bacon. At the Ottawa Station large hogs required 4 2-3 pounds of grain per pound of gain. When fed whole ⅛ of the grain passed through the intestines undigested. As an exclusive grain ration barley gave good gains and made exceptionally firm bacon at the Ontario Station. When fed alone better gains were made on barley at that station than when mixed with other grains. Its feeding value was increased by the addition of roots to the ration.

At the Colorado Station barley equaled corn for growth and fattening. Bald barley was slightly better than common barley. With ground bald barley 3.6 pounds were required to produce a pound of gain. Both ground bald and ground common barley proved equal to corn meal. In experiments at the Minnesota Station 100 pounds of barley meal equaled 119½ pounds of corn meal, but with older hogs corn was superior and always cheaper. When fed exclusively over a long period it produced slow gains and caused a loss of appetite. At the Washington Station barley chop alone was found more profitable than wheat alone. At the Michigan Station it required about 5 pounds of barley meal to make a pound of gain as compared with 4.4 pounds of corn meal for hogs weighing between 135 and 150 pounds.

With hogs 14 months old at the Wisconsin Station 36 pounds more barley meal was required to make 100 pounds of gain than of corn meal. The same difference was noted when skimmilk was added to both rations. Hogs fed on barley meal drank more water. On the whole barley meal was found a very good and satisfactory grain ration for hogs by this station, but it was not equal to corn for fattening purposes. Pigs relished barley meal most when soaked in at least 3 pounds of water to each pound of meal. Barley is an exceptionally safe and valuable feed for pigs whether fed alone or in combination with other feeds.

BRAN—This feed was found undesirable for pigs by the New Hampshire Station, whether fed alone or with corn meal. Its value was slightly improved by fermentation. Bran is a valuable feed for breeding stock, but is unsuited for young stock, and when fed to fattening pigs only limited amounts should be used.

BUCKWHEAT—In experiments at Ottawa it required 4.45 pounds of ground and soaked buckwheat to produce 1 pound of gain and 4.10 pounds of wheat to produce a pound of gain in the same trials. The percentage of dressed to live weight was greater in buckwheat-fed than in wheat-fed hogs. Hogs at this station fed exclusively on buckwheat produced soft lard and soft sides in some cases, but not uniformly. These tests show that buckwheat has a high feeding value for hogs, but is not quite equal to wheat.

CORN—Corn is the cheapest and usually the most satisfactory grain fed to hogs in the United States. It is the best of all grains for finishing off hogs, but should not be fed exclusively to young growing pigs or to the breeding stock. Experiments with this grain at the Wisconsin Station show that corn-fed hogs contain more fat and less water, and the skeleton, skin and internal organs weigh less than in hogs receiving a mixed ration. Hogs will live a long time and make good gains on an exclusive corn diet. At the Ontario Station corn produced no bad effects on the quality of bacon when used in finishing hogs which had had exercise or some milk. When fed for long periods it appeared to make the bacon soft.

In experiments at the Arkansas Station harder lard was produced on corn than on soy beans, chufas or peanuts. A large number of tests have shown that on the average a bushel of 56 pounds of corn will produce 10 to 12 pounds of pork. At the Iowa Station 1 bushel made 17 pounds of pork and 3½ to 5 pounds were required to produce a pound of pork at the Washington Station.

The relative merits of ground and whole corn for hogs are discussed under *Whole vs. Ground Grains* above. Generally corn need not be ground for hogs. Though a little better gains are made on the ground grains they are made at a greater cost. At the Wisconsin Station corn meal proved cheapest as an exclusive ration, although more was required than when a ration was fed containing corn meal and peas or corn meal and dried blood. Corn meal at the Massachusetts Station was inferior to hominy meal for hogs, but superior to cerealine meal. Corn and cob meal proved superior to corn meal alone for hogs at the New Hampshire and Missouri Stations but inferior at the Kansas Station. It is desirable to feed the cob if the expense of grinding is not too great.

Corn is the standard grain for fattening hogs. Other grains are fed, but largely as substitutes when corn cannot be easily obtained. Its value in pork production cannot be overestimated.

COWPEAS—Pigs on cowpeas and corn at the Alabama College Station made much greater gains than when fed on corn alone and there was more lean meat produced than when corn only was fed. In one experiment at the South Carolina Station it required 4.91 pounds and in another 4.43 pounds of cowpeas to produce a pound of pork. At the Alabama College Station it required 4.81 pounds of cowpeas for a pound of pork. On cowpea pasture pigs made good gains at the Maryland Station. Cowpeas are rich in protein. They are therefore especially valuable for growing pigs; but should be fed with corn for best results.

COTTONSEED MEAL—According to the Texas Station cottonseed meal is not relished by hogs and is not profitable to feed in any form or under any conditions. It kills hogs when fed very long; though the danger may be slightly lessened by boiling. As a part grain feed it proved better than linseed meal at the Wisconsin Station, pigs on linseed meal requiring 24 pounds more feed for 100 pounds gain than pigs receiving cottonseed meal. Cottonseed meal, both cooked and raw, gave very unsatisfactory results at the Mississippi Station and caused the death of some of the hogs. The Alabama College Station states that feeding cottonseed meal as part of the grain ration beyond 34 days to shoats weighing from 59 to 118 pounds usually had a poisonous effect. The younger pigs were more seriously affected than the older ones. Death or sickness was caused when one-fifth to one-quarter of the grain ration was cottonseed meal, even where green foods were given in abundance. At the North Carolina Station cottonseed meal was fed for 41 days, 20 days at the rate of 4 ounces per day and 21 days at the rate of 20 ounces per day; but the pigs lost appetite and were badly affected when fed on 2 pounds per day. At the Kansas Station cottonseed meal was fed in small quantities for a short time with profit; but in other tests it caused disease and death in from 3 to 8 weeks, even when fed in small quantities. When cottonseed meal was added to a ration of corn and cob meal at the Iowa Station it greatly increased and cheapened the gains but finally caused disease and death.

In experiments at the Oklahoma Station cottonseed meal when fed carefully with four-fifths grain ration of Kafir corn meal or corn meal, produced cheaper and better gains than corn or Kafir corn alone or mixed. That station recommends that not more than a fifth of the grain ration fed to hogs should consist of cottonseed meal, and that a rather light grain ration be fed. Add the cottonseed meal to the ration for 2 or 3 weeks, then leave it out for 2 or 3 weeks, then feed cottonseed meal again. The pigs should have range and green feed at the same time if possible. Pigs getting one-fifth cottonseed meal and four-fifths corn meal, alternating with all corn meal, required 34 per cent less grain to produce a pound of gain than when fed on a grain ration of corn meal only. It is stated by the station that cottonseed meal is not so dangerous and is sometimes quite harmless when fed to pigs on pasture. No satisfactory reasons for the death of hogs from eating cottonseed meal have yet been found. At the Kentucky Station it was successfully fed at the rate of ½ pound per day in finishing off fattening hogs when omitted from the ration in alternate weeks.

The gist of the matter from the standpoint of the feeder would seem to be that the status of cottonseed meal as a hog feed has not yet been definitely determined, and, until this has been settled by careful experiments, it is better to let it alone or feed it in small amounts varying from one-fifth to one-tenth of the grain ration, and then for only short periods at a time. There is no doubt but what it is a very valuable feed when properly handled.

DISTILLERY GRAINS—Dried distillery grains proved a very unprofitable feed for pigs at the Kentucky Station except in small proportions. Fairly good returns were secured when it constituted but one-fifth of the ration.

KAFIR CORN—This has proved a very valuable grain for hogs in Kansas and Oklahoma and some other sections. At the Kansas Station 5½ pounds of Kafir corn equaled 4½ pounds of corn for hogs. It required 6.2 pounds of Kafir corn worth 2.54 cents to produce 1 pound of gain. Hogs will not eat Kafir corn as long as corn. When soy beans and skimmilk were added to Kafir corn it made a much more relished and complete ration. Losses occurred when the grains were ground or soaked before feeding. The best results were secured in wetting the corn at the time of feeding.

LINSEED MEAL—This meal should be fed with other grains and not alone. According to the Minnesota Station it is easily digested but not a profitable feed for pigs over 100 pounds in weight. At the Maryland Station linseed meal gave better results than gluten meal for a short time but later in the experiment the gluten meal produced more rapid and cheaper gains.

OATS—Oats fed to hogs at the Utah Station gave fat and meat of excellent appearance and firmer than that from any other grain. Larger gains were also made on oats than on any other grain. At the Wisconsin Station better results were secured when oats were ground than when fed whole. The best gains were made when the ration contained 1-3 ground oats and 2-3 corn meal. When fed whole at the Ottawa Station 1-7 of the grain passed through the intestines undigested. As a continued exclusive ration oats caused a loss of appetite and small gains at the Minnesota Station. At the Massachusetts Station 100 pounds corn meal proved equal to 120 pounds oat feed. Oats may profitably form a part of the grain rations fed to hogs. They are especially desirable for growing hogs and are more effective ground than when fed whole.

PEANUTS made soft and oily fat at the Alabama Station, but the meat had a good flavor. At the Arkansas Station hogs on peanuts made almost as good gains as on corn. The hogs were allowed to root out the peanuts and made rapid gains on them. At the Alabama College Station it required 2.8 pounds of unhulled Spanish peanuts per pound of gain. They proved superior to corn meal in one test. In another test hogs made 281 pounds of pork on peanut pasture alone and 333 pounds when a small grain ration additional was fed. The value of peanuts as a succession crop was noted above under *Pasturing Hogs.*

PEAS—Ground Canada field peas were found more valuable for pork production at the Wisconsin Station than corn meal. Corn, however, was so much cheaper than peas that it was the more profitably fed. The thigh bones of pigs fed on peas were 26 per cent stronger than in corn-fed pigs. Peas should be fed to young growing pigs and breeding hogs in order to secure increased vitality. Peas mixed with bran half and half at the Utah Station were far superior to corn, barley or wheat mixed in the same manner. Wheat came second in value and then corn and barley. At the Ottawa Station peas fed whole were all digested. At that station 3.33 pounds of peas plus 2.35 pounds of skimmilk made 1 pound of gain. As an exclusive grain ration pea meal made unthrifty animals and poor gains and it is recommended that peas be always fed with some other feed. Peas contain large amounts of protein and are therefore of especial value for young hogs and the production of lean meat. They should always be fed either ground or soaked and preferably with corn meal or some other lighter feed.

PIGEON-GRASS SEED—Ground pigeon-grass seed was about equal to wheat meal for hogs at the Wisconsin Station. When ground cooked pigeon-grass seed replaced 2-3 of the corn meal in the ration, there was a saving of 13 pounds of the total ration required to produce 100 pounds of grain. Hogs did not relish pigeon-grass seed alone but ate it readily when fed with corn.

RICE MEAL—At the Vermont Station rice meal produced 23 per cent less gain with pigs than corn meal. When fed with milk at the South Carolina Station it had a feeding value equal to that of corn meal. A pound of gain was produced on 2.48 pounds of rice meal and 10 pounds of skimmilk. At the Massachusetts Station rice meal produced as good gains as corn meal in pigs weighing 60 pounds at the beginning of the test and 190 at the end.

RYE—This grain has proved about equal to barley for pork production in Danish feeding tests with 110 animals. According to the Massachusetts Station rye meal fed for a long time causes loss of appetite and digestive troubles and should be combined with wheat meal or corn meal. In Danish experiments also rye shorts produced low gains and had an unfavorable effect on the quality and softness of the pork.

SORGHUM SYRUP SKIMMINGS — This material was found more than capable of maintaining pigs at the Wisconsin Station. It is recommended that it be fed with corn meal or other feeds.

SORGHUM SEED MEAL was found by the Wisconsin Station to have 55 per cent of the feeding value of corn meal. Sorghum silage proved a poor food for hogs at the Tennessee Station.

SOY BEANS—At the Kansas Station soy beans ground and mixed with corn or Kafir corn made a saving of from 13 to 37 per cent over feeding corn or Kafir corn alone. That station recommends that they be fed whole mixed with other grains. There was a loss from grinding. At the Arkansas Station soy beans produced as firm fat as corn, but the fat was not equal to corn fat in other respects. Soy beans 1 part and corn 2 parts proved an excellent feed for pigs at the Kentucky Station.

SUNFLOWER SEED—These were readily eaten by pigs at the Ottawa Station, but their feeding value was not determined. Sunflower seed cake proved about equal to rye or barley in Danish feeding tests.

SUGAR AND SUGAR BEET MOLASSES—Sugar added to a mixed ration has given very unsatisfactory results in German feeding experiments. It was not equal to starch and hindered the formation of muscle and fat. Molasses from a beet sugar factory proved a very unsatisfactory food as a part ration for pigs at the New York Cornell Station. In some Norwegian experiments 1 pound of molasses was found equal to ¾ pound of corn.

TANKAGE—This consists of the ground refuse meat of slaughter houses. It is used as a fertilizer and contains large amounts of nitrogen and phosphoric acid. When fed to pigs at the Indiana Station in the proportion of 1 part ground tankage to 5 and 10 parts corn meal respectively, it proved extremely beneficial in growth of pigs as well as financial returns. With ½ part tankage, ½ part shorts and 10 parts corn meal, equally good results were also obtained. In all cases cheaper and better gains were made when the tankage was added to the ration than when corn was fed alone. At the Iowa Station the addition of Swift's tankage to a corn ration for hogs averaging 205 pounds in weight increased the net profits over 34 per cent. Armour's tankage increased the net profits over 7 per cent, Darling's beef meal over 22 per cent, and Standard stock food over 10 per cent. At the hight of the feeding as much as 1 2-3 pounds of tankage was fed per head daily. The results indicate a high value for tankage and similar feeds as supplemental feeds with corn for the production of pork.

WHEAT—Wheat meal at the Wisconsin Station was not quite so valuable in producing gains as corn meal, but a mixture of the two in equal parts was better than either alone. In later tests ground wheat proved equal to corn meal. Wheat should not be fed whole, either dry or soaked, but should be ground, moistened and mixed with corn meal. At the Indiana Station it cost 3 times as much to produce a pound of pork with wheat as with corn.

In experiments at the South Dakota Station more rapid gains and a better quality of meat were produced on ground than on whole wheat. Meat from ground wheat was equal to that from corn and superior to that from peas or mixed feeds. It is stated that wheat can profitably be fed as the entire grain ration, but it is better to mix it with other feeds.

At the Ottawa Station it required 4.1 pounds of soaked wheat to produce 1 pound of gain. Wheat has been profitably fed to hogs in Montana and Washington. It proved slightly superior to barley in Danish experiments. When fed with skimmilk at the rate of 3 to 6 ounces per quart it gave better results than rye meal at the Massachusetts Station.

At the Montana Station frozen wheat proved equal in feeding value for hogs to a mixture of wheat, barley and peas. The frozen wheat, even if subsequently heated by fermentation, was profitably and safely fed, 1 pound of the frozen wheat proved equal in feeding value to 7.9 pounds of skimmilk. At the Ottawa station 1 pound of gain was produced for every 5.3 to 6 pounds of frozen wheat fed to hogs weighing from 185 to 275 pounds. Wheat middlings were inferior to corn meal at the Vermont Station. At the Kansas Station ground wheat proved superior to either corn meal or Kafir corn meal. In one experiment at the Wisconsin Station shorts produced darker meat and a greater weight of liver and kidneys than corn-fed hogs. In Ottawa it required 4.4 pounds of shorts to produce 1 pound of gain. Feeding sheaf wheat to hogs at the Washington and Oregon Stations proved a wasteful and unsatisfactory practice. At the latter station the wheat was neither relished nor well digested, and it required 7½ pounds to produce a pound of gain. Generally speaking a bushel of wheat will produce 12 to 14 pounds of pork. The most economical gains will be made if it is soaked for 18 to 24 hours before feeding. With pork selling for 5 cents per pound live weight a bushel of wheat will have a feeding value of 60 to 70 cents.

Dairy Products—Skimmilk, buttermilk and whey are of great value in all stages of hog raising. At the Wisconsin Station the weights of the kidneys and liver of pigs were increased by the use of milk in the ration. Milk is easily digested and adds to the development of muscles and strength of bones. In experiments at the Ontario Station all dairy products had a good effect in making firm meat.

BUTTERMILK—Most of the station experiments indicate that buttermilk is not quite equal to skimmilk for hogs. In experiments at the Wisconsin Station buttermilk was found to be worth 28 cents per 100 pounds for hogs when sweet skimmilk was worth 35 cents per 100 pounds. In other experiments sweet skimmilk had a value of 20.6 cents per 100 pounds when buttermilk was worth but 14.7 cents for pig feeding. At the Vermont Station buttermilk had 4-5 the feeding value of skimmilk for pigs. Buttermilk proved superior to skimmilk at the North Carolina Station. Experiments at the Iowa Station show that there is nothing saved by adding the wash water from churns to buttermilk. It is too weak to be of any value as food and should be thrown out.

SKIM AND SEPARATOR MILK—When skimmilk was fed as an exclusive ration at the Utah Station the pigs made slow gains and frequently lost appetite. The best ratio was found to be 3 pounds of skimmilk to 1 pound of grain. In this proportion it proved an excellent feed, especially for young pigs. Fed with grain the skimmilk had 75 per cent greater value than when fed alone. The gain in hogs fed on milk and grain was 2.54 times greater than on milk alone and 1.7 times greater than on grain alone.

The Massachusetts Station found that skimmilk was not a profitable feed for hogs if it cost more than 1 cent per quart. At the Maine Station skimmilk was found superior for young pigs to the nitrogenous material obtained from pea meal.

In experiments at the Wisconsin Station 462 pounds of separator milk saved 100 pounds of meal when fed in the proportion of 3 pounds of milk to 1 pound of meal. The skimmilk proved to be worth 11 cents per 100 pounds when corn was worth $10 per ton. The Maryland Station states in this connection that skimmilk is worth more for hogs than the price usually charged for it at creameries. It had a value of 26 cents per 100 pounds in Vermont and 28.3 cents in Tennessee. The Wisconsin Station recommends the use of 1½ pounds of skimmilk to 1 pound of corn meal as the most economical method of using milk. With pigs 3 months old that station found that 19 pounds of sweet skimmilk was equal to 4 pounds of corn meal for growth.

The Ottawa Station states that the greater part of the ration for growing pigs may be skimmilk. That station found that 6.65 pounds of skimmilk was equal to a 1-pound mixture of peas, barley and rye, and that 8.8 pounds equaled a like mixture of peas, wheat and rye. For fattening, the station states that not more than 5 pounds per 100 pounds live weight per day should be fed. Hogs receiving skimmilk were more vigorous than those on grain alone.

Sour skimmilk has given better results at both the Vermont and Ontario Stations than sweet skimmilk, but contrary results are reported from England.

In experiments at the New York Cornell Station extending over a period of 5 years the most economical proportions of skimmilk to grain have varied from 2.5 to 10.4 pounds of skimmilk to 1 of grain. Corn has been found the best supplementary grain to feed with milk. That station concludes as a result of their work that the proportion of corn meal to skimmilk may be varied without apparently affecting the results, but in no case should the amount of skimmilk fed be greater than the pigs will quickly and easily consume.

Whey—Sweet whey has been fed to pigs experimentally at the Wisconsin Station. The pigs could not be maintained on whey alone, but when the whey was added to a mixture of corn meal and shorts it produced a marked saving when used in the proportion of 2 of whey to 1 of grain or 10 of whey to 1 of grain. The use of 760 pounds of whey saved 100 pounds of grain in the ration for pigs. It is recommended that shorts, pea meal and oil meal be mixed with the whey for growing animals.

At the Ontario Station 100 pounds of whey was equal to 13.3 pounds of mixed meal. Sour whey proved equal to sweet whey, there being no apparent loss from fermentation. Tests reported from England indicate that 2 pounds of whey were equal to 1 pound of skimmilk.

Forage, Roots, Silage, etc., for Hogs—Under this heading the value of various forage crops, roots, silage and fruits for hogs will be noted alphabetically. Their value as forage plants is also treated above under *Pasturing Hogs,* and that section should be consulted in connection with the various crops here mentioned.

Alfalfa—In experiments at the Utah Station alfalfa either pastured or cut and fed green was barely sufficient for maintenance. A loss in weight is reported from the Nevada Station when alfalfa hay alone was fed to hogs. The Montana Station reports that alfalfa is inferior to sugar beets for hogs, but saves grain as a part ration. As a supplementary feed with bran and grain the Utah Station reports profitable returns from alfalfa in winter feeding. Alfalfa hay with Kafir corn gave excellent results with hogs at the Kansas Station. One acre of alfalfa pasture at that station produced 776 pounds of pork. (See *Pasturing Hogs* above.) These tests indicate that grain should be fed with alfalfa in order to secure the best returns.

At the Colorado Station dry alfalfa hay fed to hogs induced them to eat more grain and make better gains than when the alfalfa was omitted. The Nebraska Station reports that the thigh bones of pigs fed alfalfa chaff (mostly leaves) with corn were about 65 per cent stronger than the thigh bones of hogs fed corn alone.

Apples—These have been fed experimentally to hogs at the New Hampshire Station. Even at 10 cents per bushel they were not an economical pig feed. Apple pomace when too much fermented was not relished by hogs at the Illinois Station. Some practical experience favors its use as profitable.

Cassava—When cassava was compared pound for pound with corn at the Florida Station 35 per cent better returns were made than on corn. Hogs fed on cassava made gains at a cost of 1 cent per pound, while on corn the rate of cost was 3 cents per pound. These returns show a remarkably high feeding value for this plant, which is being so successfully grown in Florida. (See *Cassava.*) They need confirmation.

Clover—Much more economical gains were made by pigs on clover pasture than in pens at the Ottawa Station, and this is the general experience of feeders. As a part of the ration for fattening hogs clover equaled 1-10 of a mixed grain meal ration. Cut clover hay added to a corn ration at the Iowa Station added nothing to the feeding value of the ration. When clover hay is fed to hogs is should be cut and steamed. It adds bulk to grain rations and tends to keep the animals in good condition in winter feeding.

Corn Fodder and Silage—Corn fodder chopped or the new corn product (see under *Corn*) proved valuable and profitable when fed to hogs at the Maryland Station.

The New York State Station states that corn silage cannot be profitably fed to hogs; they do not eat it clean, and it makes the cost of pork production too great. It was not relished by hogs at the Ontario Station. The hogs gained less rapidly when part of the grain ration was replaced by corn silage, and a financial loss resulted when half the mixed meal ration was replaced by corn silage. The Virginia Station found silage economical when fed with corn in a maintenance ration, but not so if used alone. At the Utah Station silage proved inferior to dried fodder corn. Silage in small amounts was found useful at the Kentucky Station in fattening hogs. It tended to keep the animals in a good thrifty condition; but could not be substituted as a part of the grain ration. Pea and rape silage have both been fed at a loss to hogs at the Canadian Stations. These experiments indicate that silage is not a profitable food for hogs.

COWPEA HAY added to a ration of corn and Kafir corn made a great saving in the latter at the Oklahoma Station. At the Tennessee Station it proved difficult to get hogs to eat cut cowpea hay.

GRAPES—In California hogs are sometimes allowed to harvest the second crop of grapes with profit in gains.

MANGEL-WURZELS—As much grain was required to produce a given gain when mangel-wurzels were fed at the Indiana Station as when not fed. They had no apparent feeding value. The Utah Station states that hogs make smaller gains on roots than do cattle or sheep. At the Ottawa Station 6 pounds of cooked roots equaled 1 pound of mixed grains. Tests at the Canada Experimental Farms give mangels a lower feeding value than either sugar beets or turnips.

PEA SILAGE cut with green pods was not relished by hogs at the Ottawa Station and did not seem to have much feeding value. Hogs lost weight on an exclusive ration of pea ensilage.

POTATOES—At the Wisconsin Station 443 pounds of cooked potatoes equaled 100 pounds of corn meal for fattening hogs. One bushel of corn proved equal to 4½ bushels of potatoes. That station believes that potatoes should be cooked before feeding. The Minnesota Station found that potatoes were no more digestible when cooked than when fed raw, but that pigs ate more cooked potatoes than raw ones. At the Ottawa Station potatoes either raw or cooked were unsatisfactory rations for hogs. Even when fed with skimmilk, grain had to be added. Potatoes should be cooked for hogs and fed with grain for the most satisfactory results.

PUMPKINS were better cooked than raw for hogs at the Ottawa Station, and hogs made exceedingly economical gains on rations containing pumpkins. At the Indiana Station pigs ate 26 pounds per day, made good gains and the meat was firm. The New Hampshire Station notes that in their experiments the feeding value of pumpkins was not increased by cooking. They should be fed raw, mixed with corn meal. Pigs made good gains on cooked pumpkins at the Oregon Station when supplanted with a small amount of bran.

SUGAR BEETS—These roots gave good returns when fed with grain in feeding tests at the Utah Station. They proved superior to either turnips or mangels at the Ottawa Station. At the Indiana Station the cost of grain was 27 cents more per 100 pounds in hogs fed sugar beets than in those fed grain only. Tests at the Montana Station indicate that sugar beets added to grain rations for hogs save grain, promote digestion and improve the quality of the meat. In recent experiments at the Colorado Station the feeding value of either sugar beets or sugar beet pulp did not exceed $1.50 per ton. These feeds proved valuable chiefly on account of their mechanical effects. The station states that grass will answer this purpose as well and is cheaper. Not more than 2 pounds of beets or pulp should be fed to each pound of grain. Like other roots, beets should form only part of the ration fed to hogs. They should be sliced. Cooking is likely to improve them.

TURNIPS at the Ontario Station were not found profitable when replacing ½ mixed meal ration. They were inferior to corn silage. At the Nevada Station small gains were made on turnips and alfalfa fed together.

Rations for Hogs—Hogs generally consume less food and make the most rapid gains when they are fed on mixed rations. The following table brings out this point as regards the grains. It is compiled from about 75 experiments made with more than 500 animals:

GRAIN REQUIRED FOR 100 POUNDS GAIN

Corn.	Kafir corn	Oats	Peas	Wheat	Barley	Mixed grain
Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
485	529	472	439	452	418	432

It will be noticed that it requires less mixed grain to produce 100 pounds of gain than when any single grain is used, with the exception of barley.

Exclusive grain rations for pigs are not economical. They should be fed as mixed and varied a ration as possible that will produce growth and fat. The effectiveness of corn meal was greatly increased at the Maine Station by adding pea meal or gluten meal, both during growth and during the fattening period. Young hogs on grain alone made poor use of their food at the Utah Station. Much better results were obtained by adding milk. Hogs fed on cassava, wheat middlings and cowpeas made gains at ½ the cost of gains made on corn alone at the Florida Station. Screenings and shelled corn produced pork at a good profit at the Minnesota Station.

Relative to narrow rations (see *Feeding Farm Animals*) the Virginia Station states that in their experiments narrow rations were not fed with economy and may be injurious to health. At the Vermont Station narrow rations caused more rapid gains and greater weights than rations containing more bulky feeds. The profits were greater from a ration containing moderate quantities of skimmilk than from rations containing large amounts of skimmilk. For finishing off, the station recommends 10 to 12 quarts skimmilk daily with all the corn meal that the pigs will eat. In Massachusetts wide rations gave slightly better results than narrow rations. The cost of gains on a narrow ration was slightly greater than on a wide ration at the Iowa Station. With pigs as with other animals plenty of nitrogenous foods should be fed while the animals are young and growing. These conduce to a healthy growth of all the internal organs, bones and muscles. During the fattening period more carbonaceous rations like corn should be fed. They are cheaper and generally produce more rapid gains. Even in the final stages of fattening, however, some more nitrogenous feeds, like milk, ground peas or barley, should be fed with corn. Rations for pigs in which corn forms a part will usually be found the most satisfactory.

Effect of Rations on Internal Organs, Fat, Lean, etc.—The Wisconsin Station found that the feeding of an exclusive corn ration produced an excessive development of fat in and outside of the muscles. The muscles were of small size, the hair scanty and the skin thin. The brain, heart and lungs were not changed in size, but the liver, spleen and kidneys were much reduced in size. The amount of blood was much reduced, and the strength of the bones diminished 50 per cent as compared with hogs fed a highly nitrogenous diet.

Hogs fed on equal parts of corn meal and rye meal at the same station ate more feed and made more rapid and profitable gains than hogs fed 1-3 pea meal and 2-3 wheat shorts. The carbonaceous ration in the first instance was not only cheaper, but the percentage of dressed to live weight was greater in the corn and rye-fed hogs than on the more nitrogenous ration. On the other hand, the vital organs were smaller in the corn and rye-fed hogs, and their vitality was therefore less. Another lot of pigs fed 13 weeks on shorts and bran, followed by 6 weeks of corn feeding, made more rapid and economical gains and showed larger livers and a larger proportion of muscle to fat than hogs fed the entire 19 weeks on corn. Corn-fed pigs in another test were not so smooth and had less hair than pigs fed on peas and shorts. The percentage of dressed meat to live weight was slightly larger in corn-fed pigs, but the weight of nearly all the internal organs was greater in pea-fed than in corn-fed hogs. At the Alabama Station the liver, kidneys, heart and spleen of hogs fed on cowpeas were considerably larger than in corn-fed hogs.

At the Minnesota Station it was found that the form of the skull depended on nutrition, health and the use of the muscles of head and neck. Wild hogs that root extensively have long, narrow heads. The length of the intestines in domesticated hogs is about 2½ times that in wild hogs, and apparently still increasing. This makes possible the digestion and assimilation of large quantities of feeds.

Feeding for Quality of Meat.—Corn meal made white, firm meat at the Kansas Station, while a mixture of shorts and bran made a soft, dirty yellow meat. At the Virginia Station there was no difference in the proportion of fat to lean meat in pigs fed corn meal alone and those fed corn meal, beef scraps and bran. At the Wisconsin Station shorts produced the darkest meat, milk the next and corn the lightest meat. Wheat, corn and a mixture of both produced meat of like quality at the Indiana Station. At the New York Cornell Station meat scraps and corn meal produced the largest proportion of lean meat. In other tests at the same station there was no difference in hogs fed nitrogenous or carbonaceous rations. In still other experiments the proportion of lean meat was slightly increased by a nitrogenous ration.

In an investigation of the soft pork problem by the Canadian Stations corn in large quantities was found to produce a soft pork, while oats, peas, barley and especially skimmilk made firm pork. The size of the rations did not affect firmness. Cooked or soaked feed had no superiority over dry feed in producing firm bacon. Rape, pumpkins, artichokes, sugar beets, turnips or mangels did not affect firmness.

Firm meat was secured by feeding mixed meal (barley, peas and oats) at the Ottawa Station. Corn meal and pea meal both had the effect of producing firm pork. The corn meal was rather the better of the two for this purpose. Buckwheat made soft meat. English experimenters recommend barley meal, potatoes and milk for firm, lean bacon. Barley in experiments reported from England made leaner meat than corn. In some Danish experiments linseed oil was found in the fat of hogs fed extensively on this oil. These results indicate that good, firm meat can be produced on any of the grains except shorts and buckwheat, and that grains like peas, oats and barley are better for lean bacon than corn. At the Alabama Station pigs fed on peanuts produced a soft oily pork, but of good quality. Pasturing hogs on peanuts at the Arkansas Station also resulted in soft pork and a lard that melted at a temperature of 87.6° F. as compared with 114° F. for hogs on corn. The use of skimmilk or whey in the ration practically insures firm pork or bacon.

What the Experiments Show:

That all breeds are about equally valuable for pork production.

Growing pigs require nitrogenous foods like milk and such grain rations as shorts, ground peas, oats or barley.

Exercise and pasture are essential for the most economical production of pork.

Ashes fed regularly to hogs increase the strength of the bones about 50 per cent.

Hogs may profitably follow steers.

Cooking feeds for pigs is unnecessary with the exception of roots.

The increased gains made on ground grains are not generally sufficient to pay for the extra cost of grinding.

Soaked grains can be more economically fed than dry grains. Generally soaking is equivalent to grinding.

Hogs gain most rapidly and can be fattened more economically before they have reached maturity.

Corn is the most effective grain in finishing off hogs.

Shorts, acorns, peanuts and buckwheat tend to produce soft lard and meat.

Exclusive corn rations in the early stages of growth reduce the size of the muscles, spleen and kidneys, diminish the strength of the bones about 50 per cent and reduce the quantity of blood.

Mixed grain rations are more economical and give better results than 1 kind of grain only.

Diseases: MEDICINES—For an account of the medicines and of the doses mentioned under the diseases below see *Veterinary Medicines.*

HOG CHOLERA is an infectious malignant disease due to the action of a bacillus in the intestines. The most prominent symptoms are loss of appetite, fever, discharge from the eyes, purplish coloring of the skin and constipation, followed by a profuse diarrhea, which persists until death. Affected animals usually show a rise of temperature 1° to 3° above the normal, but this symptom is frequently absent. Sick hogs are dull and lie quietly in a corner or huddle together, usually hiding the head under the bedding. The color of the discharge during diarrhea of hog cholera depends upon the kind of feed. A slight cough is often noted. The discharge from the eyes is watery at first, but later becomes thick and yellowish. The gait is staggering and uncertain and the animals have a gaunt appearance, with arched back. The symptoms, however, vary to a great extent in different cases.

The mortality from hog cholera ranges from 80 to 90 per cent. In acute attacks the animals may die within a few days, while in chronic cases the disease may extend through a month or more. The spleen becomes enlarged and soft. The large intestines may show slight hemorrhages. In the chronic form the intestines become ulcerated. In some cases, however, a general congestion and reddening of the whole mucous lining of the large intestines take place.

There is no satisfactory medicinal remedy for hog cholera. Many patent medicines have been widely advertised as cures for the disease. Careful tests with such remedies indicate that they are worthless. Good tonics may render hogs less susceptible to the disease. When an outbreak occurs all healthy animals should be removed from the sick and exposed hogs, and should not be allowed access to the same food or water supply. The carcasses of dead animals should be burned or buried and infected pens should be thoroughly cleaned or burned. Animals from suspected localities should be quarantined until all suspicion has passed.

There are at least 3 infectious swine diseases of a malignant nature, hog cholera and swine plague and swine erysipelas. In the majority of outbreaks the first 2 of these diseases occur simultaneously. (See *Swine Plague.*) The distribution of the 2 diseases is about the same, but hog cholera is perhaps the most common.

Several methods of serum treatment have been devised for the cure and prevention of hog cholera and swine plague. The serum is used either alone or in combination with virulent material. A virus has been prepared according to the Pasteur method for making blackleg virus. Extensive experiments with these methods yielded promising results, and the Bureau of Animal Industry is experimenting on a further perfection of methods in co-operation with the experiment stations. The advice of a good veterinarian should be sought in case of an outbreak of the disease.

Experiments have shown conclusively that a perfect disinfection of pens after an outbreak of hog cholera is impossible. Infected pens and refuse should therefore be burned, and the grounds should not be used for hog yards for several months.

The extensive use of swill from hotels as hog feed sometimes causes profuse diarrhea or death, and this trouble has often been mistaken for hog cholera. Such swill contains large quantities of washing soaps. These soaps, when fed to hogs in doses of from ½ to 5 ounces per day, produce diarrhea, staggering gait and a pink coloration of the skin. (Hog Cholera, U. S. Dept. Agr., Bureau of Animal Industry Rpt. 1889, Rpt. 1898, p. 235; Iowa Bul. 35; Neb. Bul. 4, Rpt. 1899, p. 64; N. Y. Cornell Bul. 141.)

Swine Plague is an infectious disease resembling hog cholera and frequently occurring in combination with the latter. In swine plague the chief seat of infection is in the lungs, and some form of pulmonary affection is nearly always the direct cause of death. Natural infection with swine plague takes place through the air passages, while in hog cholera infection occurs through the feed. A reddening of the skin indicates hog cholera rather than swine plague. It is often impossible, however, to distinguish between the 2 diseases, except by a microscopic study. For general discussion and references to literature see *Hog Cholera, Swine Plague,* Bureau of Animal Industry 1891.

Trichina Spiralis is a thread-like worm from 1-20 to ⅛ of an inch in length. In its immature stage the worm is found encysted in the muscles of various carnivorous animals, especially in man, hogs and rats. The adult worm occurs in the intestines of hogs, where it deposits its eggs. After hatching, the young worms penetrate into the striped muscles, where they remain until taken into the stomach of some animal which eats the infested flesh. An ounce of infested pork may contain 300,000 worms.

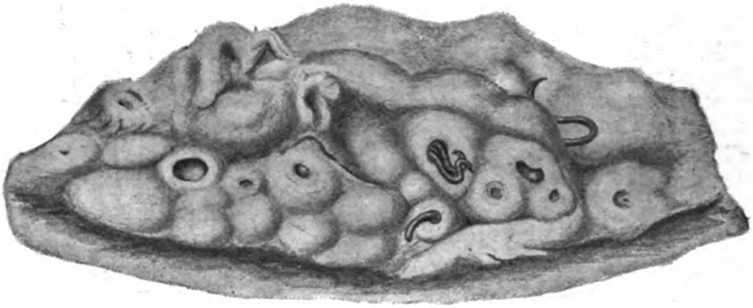


Fig. 389—KIDNEY WORM

Symptoms of intestinal infestation in hogs are grinding of the teeth, thirst and fever. After the young worms begin to enter the muscles, the pig's legs become stiff and the animal lies down. While the worms are in the intestines repeated doses of a strong vermifuge may expel them. For preventing infestation by trichina, rats should not be allowed to live in the vicinity of pigpens, since these animals are frequently infested with trichina and are killed and eaten by the hogs.

The Kidney Worm (*Sclerostoma pinguicola*), also called lard worm (Fig. 389), is a parasitic thread worm which usually infests the fat tissues around the internal organs, especially near the kidneys in hogs. Sometimes the worm penetrates the kidney. It gains entrance to the animal in water and feed. It is not often harmful, but a tablespoonful of turpentine may be given twice daily for 3 days, followed by saltpeter in doses of 1 teaspoonful. The symptoms of infestation are not characteristic and the presence of the worm may not be known until post mortem examination. (Bureau of Animal Industry Rpt. 1899, p. 612.)

Mange is a disease caused by a parasitic mite (*Sarcoptes scabiei*) and appears first near the eyes and ears and on the inside of the fore legs. Later it spreads over the whole body. The scabs formed by this mite are white and dry. The hair falls off in patches. The disease is transmitted by contact. Mange may be treated by washing the skin with weak lye or soft soap rubbed in with a brush. A wash containing white arsenic 1 pound, alum 12 pounds and water 25 gallons gives good results. Infested pens should be disinfected with hot kerosene emulsion or pure kerosene, and liberal quantities of lime on the floor.

Thumps is a popular term for palpitation of the heart, which may be due to an attack of bronchitis, the presence of worms in the intestines, or indigestion. It may be treated by jalap, turpentine or digitalis, according to the origin of the disease.

Measles of pork is a disease due to the presence of the pork bladder worm in the muscles. This worm is the immature stage of one of the common tapeworms of man. Man becomes infested by eating measly pork. The symptoms in hogs are indefinite and the disease cannot easily be diagnosed, except by meat inspection. The measles worm is found in various muscles of infested hogs, especially those of the abdomen, diaphragm, tongue, heart and neck. Measly pork should not be eaten unless cooked or otherwise treated, so as to destroy the bladder worms.

For anthrax, actinomycosis and tuberculosis of swine see *Cattle.*

Lice on pigs are of such constant occurrence that it is often desirable to dip them at frequent intervals in order to prevent the annoyance and loss of flesh which are caused by these parasites. Dipping vats or tanks may be constructed on the same plan as that used is making dipping plants for cattle, and the same materials may be used as insecticides. Zenoleum and chloronaphtholeum are perhaps preferable and may be used in a 3 per cent solution for young pigs and in a 4 per cent solution for older pigs.

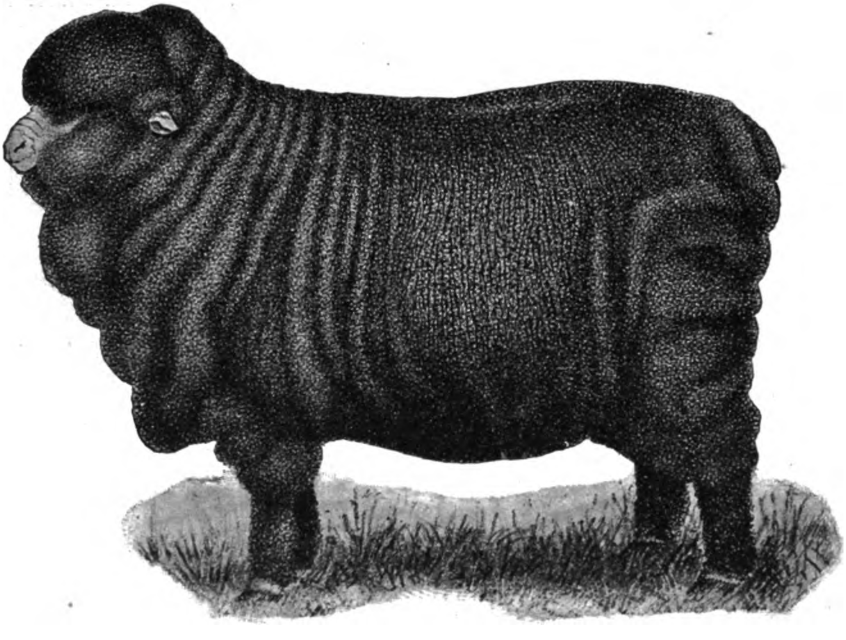


Fig. 390—TYPICAL AMERICAN MERINO EWE

SHEEP

Breeds—Sheep are commonly classified as fine wool, long wool and short or medium wool breeds. The prominent breeds of the first class in this country are the native Merinos, Mexican Merinos and Rambouillets. The short wool breeds are pre-eminently mutton sheep, and include the Southdown, Shropshire, Hampshire, Dorset, Suffolk and Oxford breeds. Among the long wool breeds are the Lincoln, Cotswold and Leicester. The Cheviots may also be classed with the long wool breeds.

MERINOS—The native American Merino (Fig. 390) is a lineal descendant of the old Merino flocks of Spain. These sheep were first brought to this country in 1801. Under the skillful direction of American breeders their carcass has been increased in weight 25 per cent, the weight of the fleece doubled and the quality of the mutton much improved. American Merino flocks of to-day are the best of their kind in the world. Full grown Merino rams weigh from 120 to 180 pounds, and the ewes about 40 pounds less. The skin of the Merino is characterized by heavy folds, the wool is fine and very dense and the fleece will average from 10 to 15 pounds in the ewes and considerably more with the rams.

The Merino is a hardy sheep and a good rustler. It thrives in bands of thousands where the pure mutton breeds cannot be successfully herded in flocks of over 200.

With the decline in price of wool in late years the Merino has been largely crossed with the mutton breeds for the purpose of producing an all around wool and mutton sheep. Starting with pure Merino ewes and a pure Shropshire buck and using thereafter a pure Shropshire buck on the grade ewes, the Wisconsin Station succeeded in producing at the second and third crossing grades that could scarcely be distinguished from pure Shropshires. Several forms of the Merino have been developed, such as the Dixon, National Delaine (Fig. 391), etc.

MEXICAN MERINOS — The Mexican Merino (Fig. 392) on the ranges of the Southwest is also a descendant of Spanish flocks. It has been bred in Mexico for almost 200 years without any outcross or improvement. It has long legs, a long, thin body, small and rather long neck, and a long, thin head carried high. These sheep are excellent rangers. The wool is fine and thin, and though they appear valueless for mutton they feed well and bring top prices in the Chicago market.

RAMBOUILLET (Fig. 393)—These are French Merinos built up from old Spanish Merino stock under government supervision and improved by careful selection and breeding since 1786. They are larger than the American Merino, full grown ewes weighing up to 200 pounds and rams to 300, live weight. These sheep have become very popular in this country during the past few years. They produce an especially fine fleece.

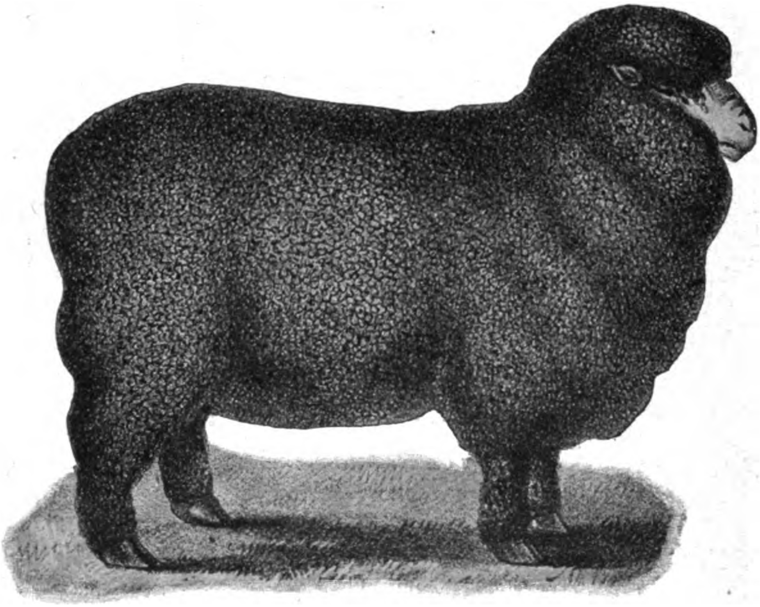


Fig. 391—DELAINE MERINO EWE

which contains less gum and yolk than the American Merino fleece, and the mutton is of exceptionally fine quality. This combination of wool and mutton in the same sheep should make this breed remembered when a general purpose flock is to be established. Rambouillet rams are now largely used in alternation with Cotswold rams in flocks on Western ranges. (See *Sheep Ranching* beyond.)

Southdown (Fig. 394)—Practically all the improved mutton breeds of sheep are of English origin. The Southdown has been the basis of all the later so-called Down breeds, and is the type of a short wool mutton sheep. It is a smooth, round-bodied, symmetrical sheep with brown, gray or mouse-colored feet and face. The fleece is rather dry, coarse and light. A good fat 2-year-old wether will weigh from 130 to 140 pounds. "The prominent characteristics of the Southdown are vigor, precocity, fecundity and well-marbled flesh at the most desirable points. They are especially desirable for crossing where mutton production is chiefly sought."

Shropshire (Fig. 395)—This is one of the most popular breeds of mutton sheep in this country. It is a well-proportioned, symmetrical sheep, a little heavier than the Southdown, the ewes weighing up to 175 pounds and the rams to 225 pounds. The face is grayish-black and the legs still darker. The wool is more compact and a little longer than Southdown, and the fleece will average 7 to 9 pounds in weight. It is a hardy sheep, does well on thin pastures, takes on flesh rapidly when fattened for market and is unusually free from common sheep diseases. It is one of the best general purpose sheep for farm flocks. At the Wisconsin Station Shropshire ewes proved more prolific than any other breed or cross except the fourth cross of Shropshire rams on Merino ewes.

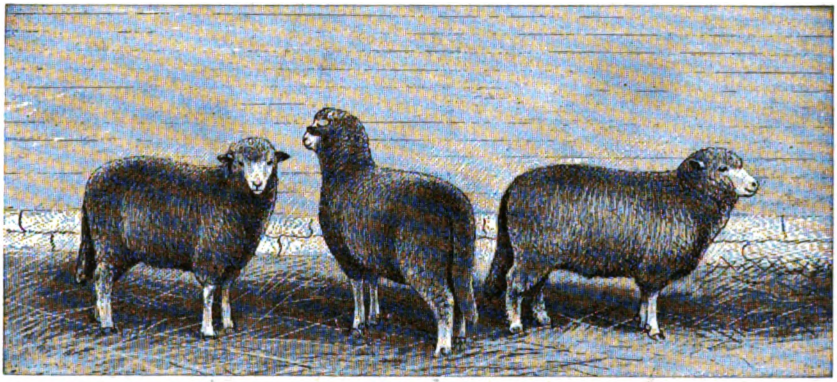


Fig. 392—REPRESENTATIVE MEXICAN MERINO LAMBS
(After Wilson and Curtiss)

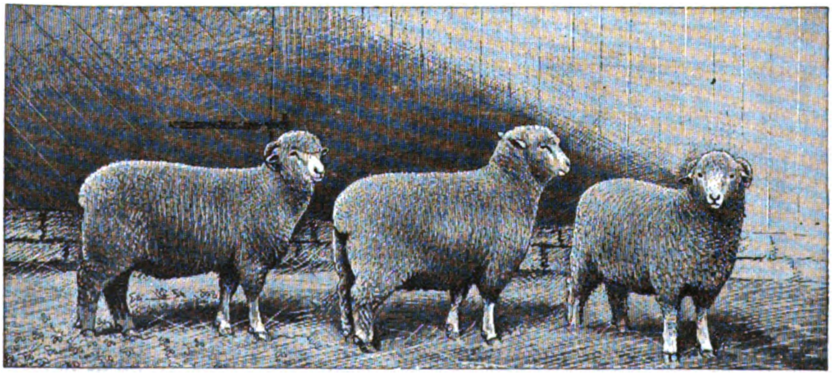


Fig. 393—REPRESENTATIVE RAMBOUILLET LAMBS
(After Wilson and Curtiss)

Hampshire (Fig. 396)—The Hampshire is a hornless, black-faced, black-legged sheep, like the Southdown and Shropshire. It excels the Southdown in size, but otherwise is very similar to it. The breed is not prominent in the United States, though possessing many commendable qualities and held to be particularly valuable for crossing on scrub ewes.

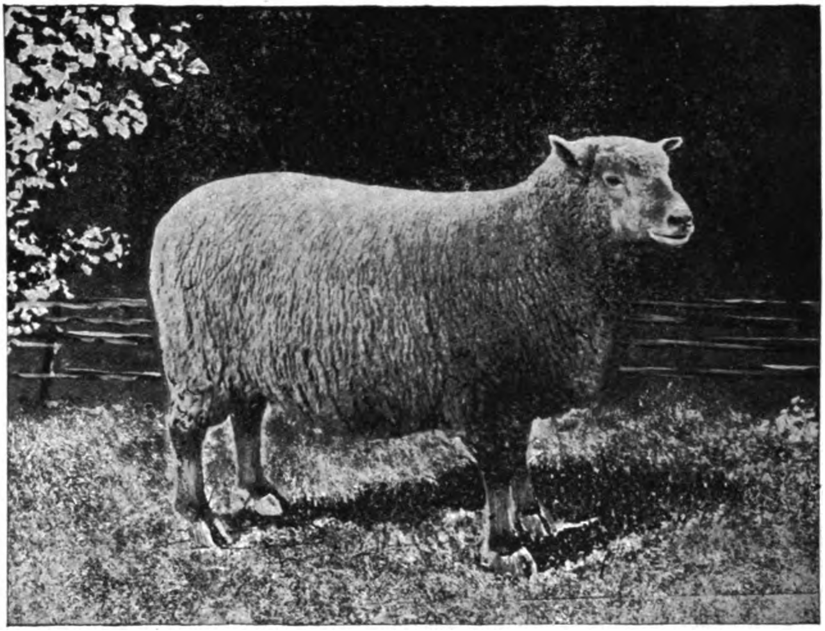


Fig. 394—TYPICAL SOUTHDOWN EWE

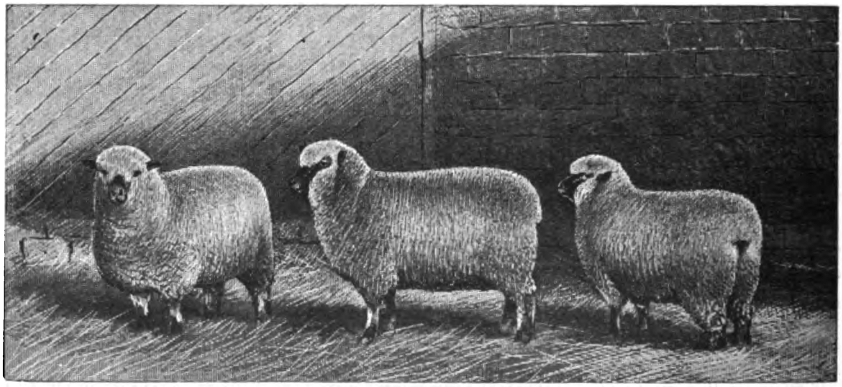


Fig. 395—REPRESENTATIVE SHROPSHIRE EWES
(After Wilson and Curtiss)

Oxford (Fig. 397)—The crossing of Cotswold rams on Hampshire ewes and the selection and mating of the progeny has resulted in what has been known since 1857 as Oxfordshire Downs or Oxford sheep. They resemble the Hampshire in many respects, but are larger, breed later and the face is not so dark. The mutton is of excellent quality.

Suffolk (Fig. 398)—The Suffolks are nearly as large as the Hampshires and Oxfords, but are not quite so heavy.

Dorset (Fig. 399)—Of this sheep Henry Stewart, in "The Domestic Sheep," says that of late years this breed has become exceedingly popular, mostly on account of its special fecundity and early breeding habit. Under right management 2 lambing seasons a year are possible with this breed. It is a white-faced sheep, with a coarse, short fleece weighing 4 to 5 pounds. It is solidly built, having a broad back and short legs. It has a tuft of wool on its forehead, and the ewes are horned as well as the rams. It is larger than the Southdown, and although most esteemed for its prolificacy its mutton is of high quality. The ewes weigh from 140 to 160 pounds. They are a hardy sheep, well suited to our cold winters and hot summers and adapted to the ranges, being excellent travelers and rustlers. Their most prominent characteristic, however, is their unrivaled fecundity. Taking the ram in May they rear lambs ready for the holiday markets, and breeding again soon after dropping the lamb, bring another in March or April. Often twins, and sometimes triplets, are produced. It is the usual custom to breed the ewes to a Southdown or Hampshire ram in order to give the market lamb a black face, which is generally preferred by the butchers. No other breed is so prolific as this under skillful management. By crossing common grade ewes with a pure bred Dorset ram for 2 or 3 generations and preserving the earlier dropped lambs for breeding uses the Wisconsin Station found that a flock can be built up which will drop their lambs in the fall and early winter instead of the spring. Such ewes can then be mated with the dark-faced mutton breeds to secure a superior quality of winter lambs for forcing. (See also *Hothouse Lambs* beyond.)

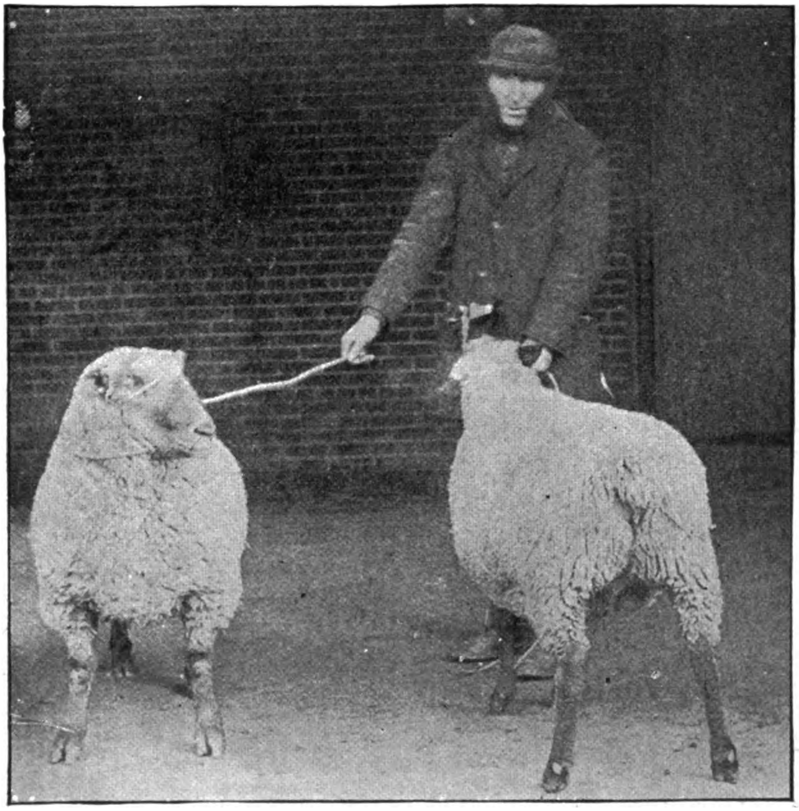


Fig. 396—HAMPSHIRE DOWN SHEEP

Lincoln (Fig. 400)—The Lincoln is the most prominent of the long wool breeds, and, like all these, is without horns. It is the heaviest of the mutton breeds. Its wool is 8 to 10 inches long and in high favor for making into the worsted class of goods. This breed has a white face and a conspicuous tuft on the forehead. In a test of breeds at the Iowa Station the Lincoln sheep produced the heaviest fleece, and the fleece which sold for the most money of any of 10 pure breeds under observation.

Cotswold (Fig. 401)—This is perhaps the most popular long wool breed in America. It stands next to the Lincoln in size and in weight of fleece. It has a well-poised head with characteristic foretop, straight, broad back, well-rounded body, with a full brisket. The fleece is 8 to 10 inches long and weighs from 8 to 16 pounds. It is the oldest of the improved English breeds, possesses a hardy constitution and is well adapted for crossing on smaller Down and Merino breeds for increasing the weight of the lambs, lengthening the fleece and improving the quality of the mutton.

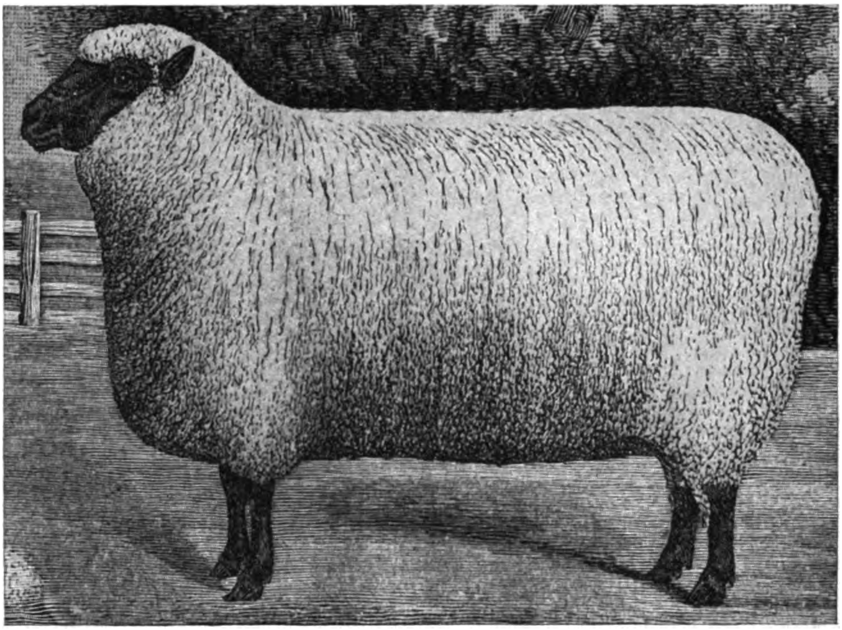


Fig. 397—OXFORD DOWN EWE

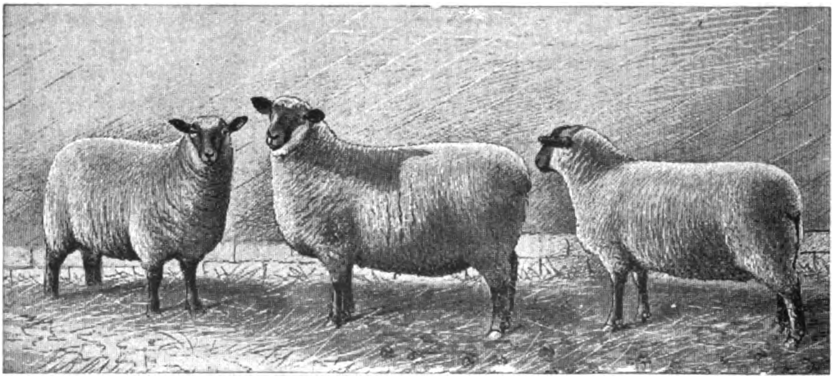


Fig. 398—REPRESENTATIVE SUFFOLK LAMBS
(After Wilson and Curtiss)

Leicester (Fig. 402)—This breed while popular in England is little grown and not highly esteemed by breeders here. It produces a good fleece and an excellent quality of mutton, but is not so hardy as some of the other breeds, besides requiring extra nutritious food and care for successful breeding.

Cheviots (Fig. 403)—This is a mountain breed of sheep, hardy, and does well on scant pasture. It is grown very successfully in New York, Indiana, Iowa, Pennsylvania and North Carolina. Cheviot mutton is of superior quality. The fleece of the ewes will weigh from 6 to 8 pounds. The ewes weigh about 150 pounds and the rams 200 pounds. The breed is pure white except the nose, which is black. The breed is of unusually strong constitution, excellent foragers and will secure a living where others might fail.

There are a number of other breeds of sheep, but they are not of sufficient general importance to justify their description in this brief article. The handling of sheep and their feeding will therefore be described, basing the recommendations made on the results of experimental work in this and other countries.

Winter Shelter for Sheep—Sheep on Eastern farms require winter shelter if they are to be profitable. If the flock is left out in driving rains and snow storms the fleece becomes wet through, the sheep chilled, and colds, snuffles and other disorders follow. Sheep will endure almost any amount of cold if it is dry cold. The shed or barn need be only 1 thickness of matched boards except when winter lambs are raised in the North, then quarters warm enough to prevent the chilling of the new-born lambs are needed. Ventilation of sheep sheds is necessary, and for much of the winter the door of the shed may be a wide slat gate. Direct drafts on the sheep must always be avoided.

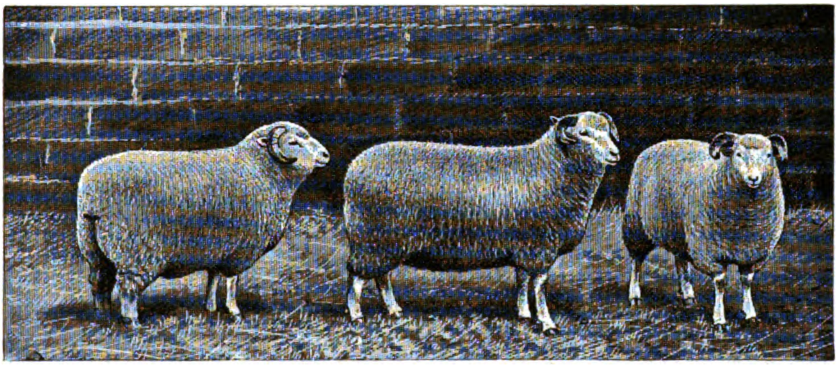


Fig. 399—REPRESENTATIVE DORSETS
(After Wilson and Curtiss)

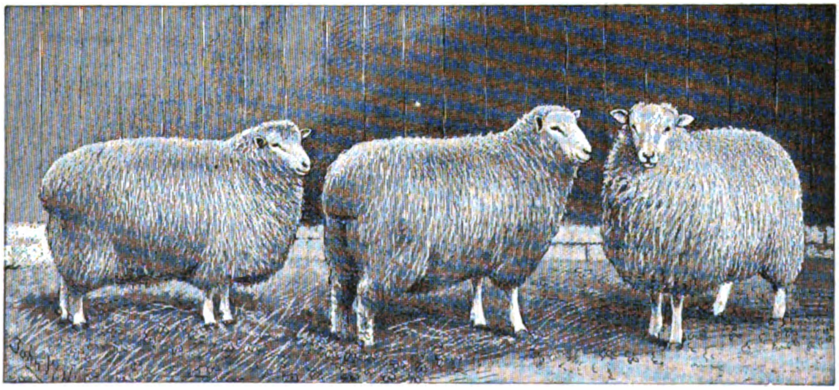


Fig. 400—REPRESENTATIVE LINCOLN LAMBS
(After Wilson and Curtiss)

The shed space should be about 10 square feet of floor surface for each sheep weighing 100 pounds, or 15 square feet for each sheep weighing 150 pounds. A shed 20 by 40 feet will therefore be required for a flock of 80 sheep weighing 100 pounds each, or 50 sheep weighing 160 pounds each. From 18 to 24 inches rack space will be needed by each sheep. The illustration (Fig. 404) shows one of the best forms of feeding racks for sheep.

The broad wings prevent dirt and chaff getting into the wool of the sheep and decreasing its value. Feeding racks should have a flat, shallow bottom made of a single bottom board about 15 inches wide. Where grain is fed this prevents the sheep from bolting their rations.

Sheep Yard—The sheep yard should be dry and have a sunny exposure. It should be protected from bleak, cold winds and driving storms. The yard should be well littered with straw and the sheds comfortably bedded. Well-arranged sheep feeding pens used for large flocks in the West are seen in Fig. 405. Sheep require plenty of fresh air and sunshine and will not do well if confined in barns warm enough for dairy cows nor in stone basements with damp walls.

Dividing the Flock—The flock should be divided, putting the breeding ewes in one flock and the lambs in another. If the wether lambs are to be fattened they should constitute a third flock.

Feed for Breeding Ewes—The ideal winter roughage for breeding ewes in the North is good clover hay, and in the West alfalfa. Well-put-up corn fodder stands second in value. It proved superior in feeding value and cheaper at the Wisconsin Station when fed with oats and bran than either oat straw or blue grass hay and the same grain ration. The cost on corn fodder was but 1 cent per day per ewe. Next in value stand good prairie hay, cut oat straw, pea straw, barley straw, sorghum, etc.

In addition to these coarse fodders each ewe should be given ¼ to ½ pound of grain daily. With clover or alfalfa less grain will be required than when corn fodder or straw is fed. The grain ration should be made up preferably of whole oats, peas or bran or a mixture of these. The ewes require grains that will supply nourishment for the developing fetus rather than fattening grains like corn, which should be fed sparingly. A couple of tablespoonfuls of oil meal or linseed meal may also be profitably fed each ewe daily, and some succulent food like silage or roots. Corn silage proved as efficient and considerably cheaper for breeding ewes at the Wisconsin Station than clover silage or sugar beets. In one

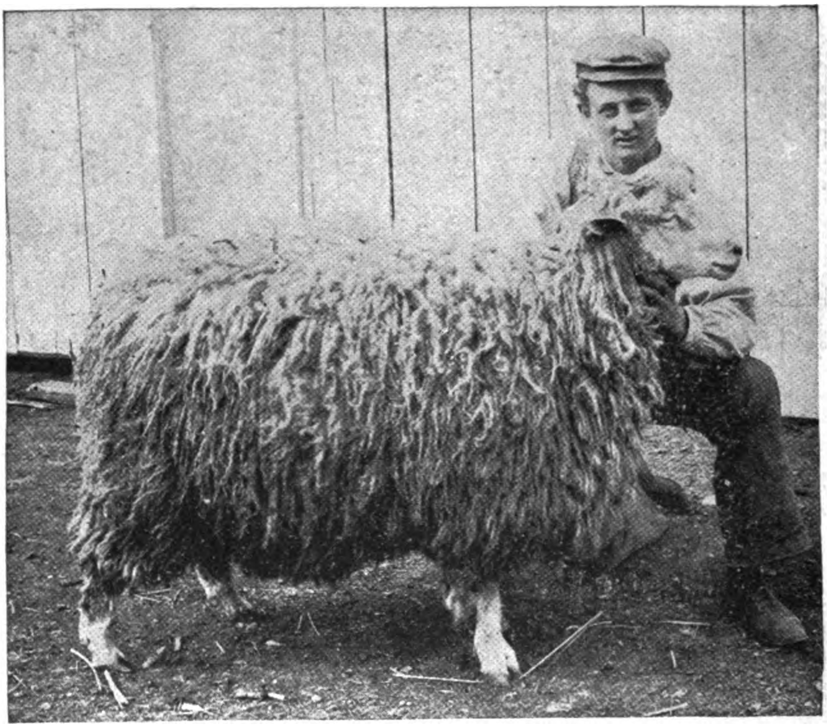


Fig. 401—YEARLING COTSWOLD RAM

experiment the heaviest lambs were produced when the ewes were fed ½ pound of grain per head daily with 2½ pounds of corn silage and 2 pounds of mixed hay. As regards the milk supply of the ewes at lambing time the heaviest flow was secured when dried brewers' grains were fed. This also proved one of the cheapest rations fed.

While it is the plan of many farmers to feed the breeding ewes on only the roughage of the farm, and generally without grain, it is not economy to do so, and weak-constitutioned lambs that feed badly and a degenerating flock results.

Flushing Ewes—This is an English practice to secure twin lambs. For 2 or 3 weeks before breeding time the ewes are given an extra supply of nutritious, palatable food so that they may be gaining in flesh when breeding takes place. Well-fed ewes have more twin lambs than poorly-fed ones, and tests at the Wisconsin Station show that ewes can raise twin lambs without losing any more flesh than when nursing a single lamb and that twin lambs nursing 1 mother gain as rapidly as when there is but 1 lamb nursing. Where the lambs are fed well, as is usually the case with the mutton breeds, twins are very desirable. Under average Western range conditions, however, where less attention can be given the flock, 1 lamb to each ewe has given most satisfactory results. At the Wisconsin Station ewes bred early in the mating season to a single ram dropped a larger percentage of lambs than when bred near the end of the season. Ewes 3 to 6 years old were most prolific.

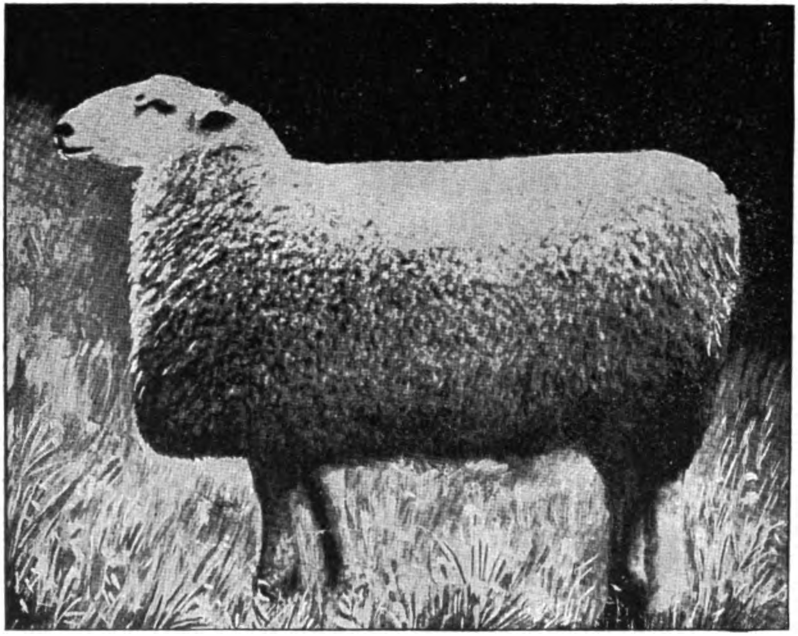


Fig. 402—LEICESTER RAM

Cost of Wintering Breeding Ewes—The daily cost of wintering breeding ewes at the Iowa Station in a comfortable barn with food and water handy was as follows: Merinos, 1.03 cents; Cotswolds, 1.35 cents; Dorsets, 1.21 cents: Oxfords, 1.32 cents; Hampshires, 1.26 cents; Shropshires, 0.97 cent, and Southdowns, 0.6 cent per head. The ewes were given sufficient hay and grain to maintain them in good breeding condition. This test places the Southdowns first as the cheapest breed to winter, followed by the Shropshires, both costing less than 1 cent per head per day.

Buck, Management—The buck is half the flock. The money put into a good, first-class buck soon repays itself. Not a highly-fed show buck, but a strong, vigorous animal and a good getter of lambs. One buck is required for every 50 ewes. The buck should be turned in with the flock at night during the breeding season and removed in the morning. He should be kept in good condition on such grain rations as peas, oats, bran, etc., with good clover or alfalfa hay. One-year-old rams may be used but are not so prolific as rams 2 to 3 years old.

Sterility—English experience shows that in ordinary flocks about 4 per cent of the ewes are barren and 3 to 4 per cent more abort. Such ewes should be culled immediately from the flock and fattened for mutton.

Lambing—The period of pregnancy for sheep is about 21 weeks. Large lambs are carried a little longer than small lambs. In records secured at the Missouri Station the size of the lamb at birth appears to be influenced entirely by the size of the mother, large lambs being produced by heavy ewes and vice versa. The size or breed of the ram appeared to have no influence on this point. Male lambs are usually a little larger than ewe lambs. Heavy lambs made more rapid gains for the first 7 weeks than lighter lambs. The milk yield of ewes was found to vary from 1.83 to 3 pounds per day.

At lambing time the shepherd should be in constant attendance day and night. Especially is this desirable with the mutton breeds. If twins are born the ewe frequently gives attention to only the stronger one. The shepherd should see that the weaker one gets its full supply of food. If the young lamb is unable to suckle within a few minutes after birth it should have help, and it is often necessary to catch and hold the ewe for this purpose.

If the ewe refuses to own her lamb she must be shut up alone for a while with it in a small pen until she does own it. Sometimes the ewe dies in giving birth to the lamb, in which case it may be necessary to give the lamb to another ewe or bring it up on cow's milk fed in a bottle with a rubber nipple over the end. At first the cow's milk should be warmed and fed 12 to 15 times daily, and finally only 5 to 6 times daily.

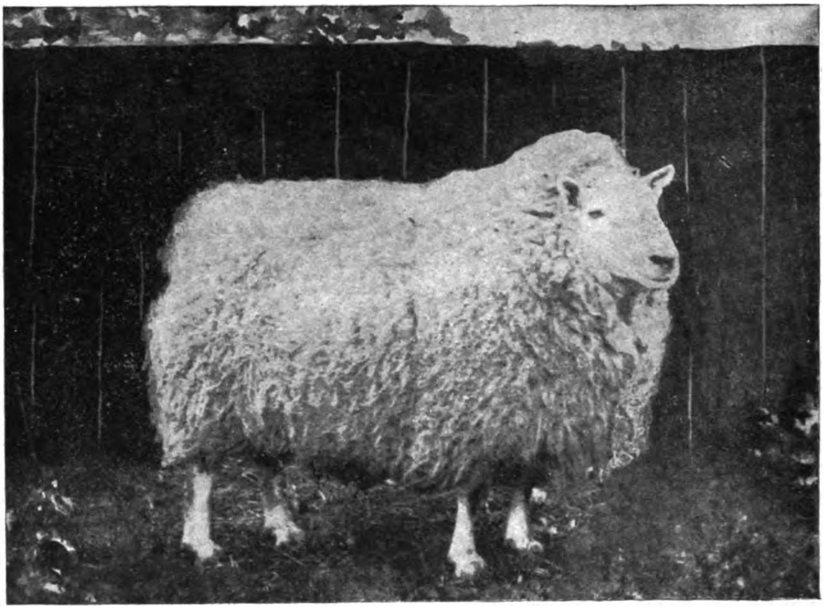


Fig. 403—TYPICAL CHEVIOT EWE

Should a lamb become chilled, Coburn in "The Modern Sheep" advises that it be put at once into a pail of water as hot as the hand will bear, keeping only the head out so that it can breathe. If the lamb is so cold as to chill the water pour it off and cover again with hot water. It may be necessary to repeat this 2 or 3 times, if the lamb is seriously chilled, before it becomes active. It should then be rubbed dry with a towel and fed. It can usually be put back with the flock within an hour and will require no further attention. After lambing the ewe should be fed sparingly on dry foods for 2 or 3 days. As the capacity of the lamb for milk increases the ration may be increased and more succulent foods added. With the coming of mild weather in the spring the lamb will be ready to go to pasture with its dam. On good pasture the ewes will require no grain.

Weaning Lambs—When lambs are about 4 months old they should be weaned, both for their own sake and the sake of the ewe. On this point Henry in "Feeds and Feeding" says: "Let them be so far separated from their dams that neither can hear the bleating of the other. For a few days the ewes should be held on short pasture or kept in the yard upon dry feed. Their udders should be examined, and, if necessary, as is often the case with the best mothers, they should be drained of milk a few times lest inflammation arise. At weaning time the lambs should be put on the best pasture and given a liberal supply of grain in addition in order to mitigate the effects of weaning."

Water and Salt—Sheep require to be supplied with fresh water. There may be times in wet weather or with heavy dews or in the feeding of very succulent foods when this is not necessary, but it is wise and profitable to provide from 1 to 6 quarts per head per day of fresh water. At the Montana Station in some winter fattening experiments lambs allowed constant access to fresh water gained over 2 pounds per head per month more and made gains a cent a pound cheaper than lambs fed the same foods but allowed water only once a day. On the arid ranges of the Southwest sheep while grazing on certain succulent plants sometimes go 60 days without water. In the Northwestern States sheep are watered once, twice or three times per day, or, more rarely, every other day. Cold water proved as satisfactory as warm water for fattening lambs at the Colorado Station.

Salt is essential for sheep and should be fed at regular intervals. Rock salt in lump form left where the sheep can get at it at will is a satisfactory method of feeding it. On the Western ranges some sheep raisers never salt their sheep, but allow them to eat alkali. The belief is gaining ground, however, that salt is better than alkali and that salted sheep are less likely to become locoed. Alkali may, however, contain 80 per cent of salt, and is then quite safe for sheep.

Feeding Lambs Grain Before and After Weaning—Whether or not it is advisable to feed lambs grain from birth or from weaning time until they are fattened for the market at 9 to 12 months of age is a question of importance to sheep growers. Some of the best and most conclusive experimental work in answer to this question has been done by the Wisconsin Station. The results of the station's first experiments showed that "when the ewes have been properly fed during the winter so as to be in good condition at lambing time it does not pay to feed them grain when on good pasture with the object of securing more rapid and profitable gains in the lambs." In the following 5 years' work of the station in feeding lambs grain from birth, from weaning time, and withholding it altogether until the winter fattening period, the important conclusion was drawn that it is financially profitable to feed lambs a grain ration continuously from birth, particularly if the lambs are to be sold at weaning time or in the fall; and the further conclusion is drawn at the same time that the grain ration after weaning when the lambs are on good pasture should not exceed ½ pound per head per day. The profit comes from the higher price that the mutton from the grain-fed lambs brings in the market and the fact that the grain-fed lambs are always in such condition that the feeder can take immediate advantage of any favorable rise in the market.

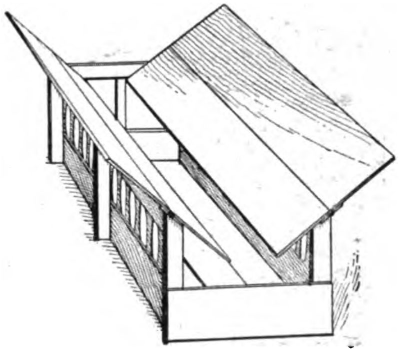


Fig. 404—SHEEP FEEDING RACK

When put on winter fattening rations the grain-fed lambs have made just as rapid gains as lambs that never had grain until the fattening period began and weighed as much 4 to 7 weeks from the end of the fattening period as the others did at the end. Methods of handling lambs to induce them to eat grain early in life are considered under *Winter or Hothouse Lambs* beyond.

On good blue grass pasture at the Iowa Station yearlings made practically as good gains and considerably cheaper gains as when grain was fed in addition. Mutton was made much cheaper in the summer on grass alone or grain and grass than by feeding grain and hay in the fall and winter. At the Minnesota Station wethers fed a small grain ration while on good pasture made 60 per cent better gains for 112 days than wethers without grain.

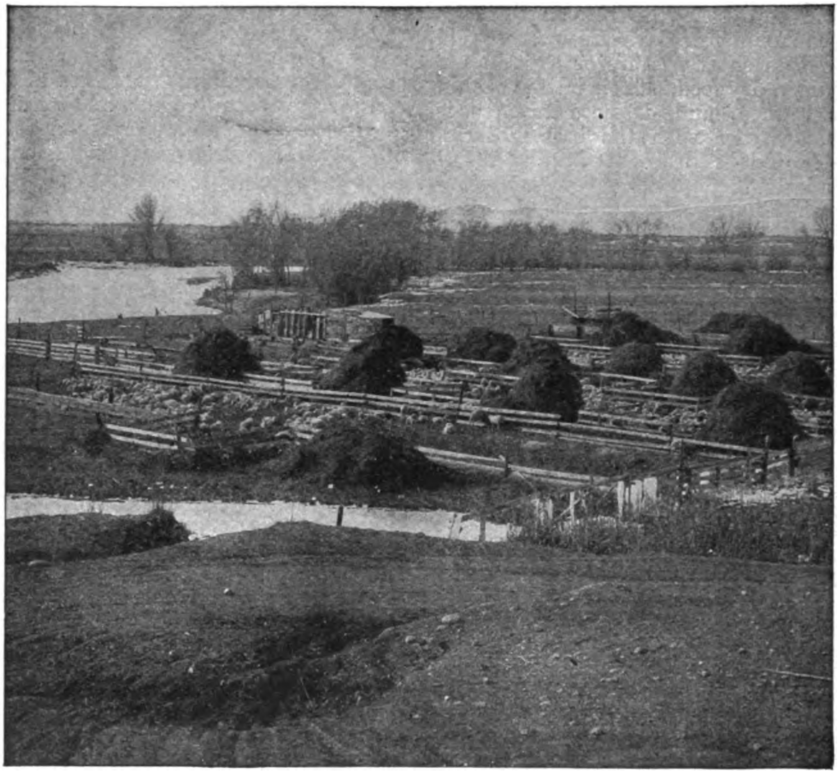


Fig. 405—SHEEP FEEDING PENS
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 90)

Grains for Lambs Before and After Weaning—After it had been decided by the Wisconsin Station that feeding grain to lambs both before and after weaning was a profitable practice the next step was to ascertain what kind of grains could be most profitably fed. Accordingly the relative merits for this purpose of corn, whole oats, bran, cracked peas, corn and oats, and corn and peas were studied. Estimating corn at 30 cents per bushel, oats at 20, peas at 45 and bran at $13 per ton, the cheapest gains in every test either before weaning or after weaning have been made on ground corn, and especially is this true of all the experiments before weaning. Coarsely cracked peas have given as good or even better gains before weaning, and the lambs have appeared to relish them more especially as they grew older, but the cheapest gains have been made on corn. Bran has stood next to corn in these tests, but has never given very good results when fed to very young animals. It seems to be too bulky and not easy of digestion. It is also a fact that where the grain ration consists wholly of ground corn greater watchfulness is required, and there is likely to be more sickness among the lambs than if they have a mixed ration. The addition to the corn of oats or peas makes a ration that the lambs seem to relish, but aside from this the mixture produced no appreciable benefit, while it regularly increased the cost. Oats and peas were about equally valuable, and the gains in weight on these feeds were about equal to those made on corn either before or after weaning, but they were more expensive rations. Coarsely ground corn and peas seemed to be much more relished by the lambs than finely ground.

Rape for Lambs—Dwarf Essex rape is yearly growing in favor and importance as a fall pasture crop for sheep, particularly in the Northern States and Canada, and also as a summer soiling crop for breeding ewes. Seeded in May the crop is ready for the first cutting about 2 months later, and 2 more cuttings can be obtained by snowfall, or about 30 tons of green fodder per acre. The plant should be cut each time about 4 inches from the ground in order to secure the greatest abundance of new shoots.

As a fall pasture crop for fattening lambs the average results at the Wisconsin Station show a weekly gain on rape of 2½ pounds per head. With the rape about 1 pound of grain was fed daily to each sheep in addition. In one test at the station 2 like lots of 48 lambs each were fed the same amount of grain, but one lot was pastured on blue grass and the other on rape. In 4 weeks the rape-fed lot had gained 501 pounds and the lot pastured on blue grass 325 pounds. The lambs were then put up for the winter and fed like hay and grain rations. In 12 weeks the rape-pastured lambs gained 952 pounds and the lot pastured on blue grass 858 pounds, thus giving evidence of the value of rape in preparing lambs for winter feeding.

At the Michigan Station 125 grade Shropshire lambs were fall pastured for 7½ weeks on 15 acres of rape and made an average weekly gain of 3 pounds per head. The rape-fed lambs at that station have invariably been in better condition for fattening in November than grass-fed lambs, and in comparison have made practically as good gains in winter grain feeding. As a rule, the station states, lambs may be pastured on rape from September 15 to November 15 at the rate of 15 to 20 lambs per acre and gain 20 pounds each. Lambs should never be put on rape without first pasturing them a few hours on grass or giving them a feed of hay and grain. Otherwise they are very liable to bloat and some of them be lost. The flock should be accustomed to the rape gradually, and in the beginning should not be left on more than 2 hours at a time. After 5 or 6 days they may be left on all the time, but must be carefully watched, and if any signs of bloat appear should be promptly driven from the field. It is much safer if some other pasture is fed in connection with the rape. Before turning the lambs on the rape they should be docked and trimmed.

Bloat—Should bloat occur a tablespoonful of spirits of ammonia given in ½ pint of warm water will usually relieve the first stages. If the lamb is down and the stomach greatly distended it should be punctured at the point of greatest swelling on the left side with a trocar and canula or knife.

Pasturing Sheep on Alfalfa—Sheep pastured on alfalfa are very liable to bloat. Some sheep are practically certain to be lost, but the danger can be largely overcome and the loss reduced to at least 5 per cent by the careful observation of certain precautions. These are stated by the Colorado Station as follows: The sheep should be kept in small bunches. The field should be large enough to supply them with an abundance of food with but little effort. They should be left in the field night and day and not removed when the field is irrigated. Keep water and salt within their reach all the time and provide shelter from sun. They should be filled up with some other food and not thirsty when turned on the alfalfa. Old sheep are more liable to bloat than lambs.

Lambs vs. Yearlings for Feeding; Mexican Lambs—The Iowa, Minnesota and some other stations have made special tests to determine the relative merits for fattening of lambs (6 to 9 months old), yearlings and 2 and 3-year-old wethers. As a rule the lambs have gotten about a half more out of the food given them than the older sheep. The lambs gain faster, make a pound of mutton cheaper and sell for a higher price in the market. Yearlings and older sheep should be bought for considerably less per 100 pounds than lambs if they are to be fed at a proportionate profit. The Colorado Station has shown that large lambs make better and cheaper gains than small ones of the same age. In tests at that station Mexican lambs have been fed at a greater net profit than Mexican yearlings, grade Merino lambs or grade Merino yearlings, whether figured per dollar invested or per ton of hay fed. Lambs also shrunk less in shipping to Chicago and in dressed weight than yearlings. At the Minnesota Station

Merino grade lambs made poorer and more costly gains than Shropshire, Oxford or Cotswold grade lambs.

Influence of Breeding on Feeding Qualities of Lambs—Shropshire grade lambs grown under indifferent management and in flocks where little attention had been given to the selection of good rams, and the culling of the flock, were fed at the Wisconsin Station in comparison with average wether lambs from the carefully managed station flock. Both lots were given all they could eat of corn fodder and a mixture of equal parts corn and peas. The average weekly gains were 2.27 pounds per head for the scrub lambs and 3.6 pounds per head for the well bred lambs. The cost of 100 pounds of gain with the scrub lambs was $4.58 and the profit per head 65 cents. With the well-bred lambs the cost was $4.08 per 100 pounds of gain and a profit of $1.13 per head. The sire is considered half of the flock and this nearly double profit of the well-bred over the scrub lambs shows the value of a well-selected sire at the head of the flock where mutton sheep are concerned.

Shelter for Fattening Sheep—What few experiments on this subject there have been at the experiment stations would seem to indicate that while sheep can be successfully fattened outdoors without shelter, the more economical gains are made when shelter from rain, snow and driving storms is provided.

Self Feed for Fattening Sheep—A "self feed" is an arrangement by which sheep may supply themselves with grain at any time. It makes a convenient way of feeding sheep since all that is required is to see that the "feed" is supplied with grain at all times. Lambs thus fed at the Michigan Station made an average weekly gain for 3 years of 1.87 pounds per head and required 9.57 pounds of dry feed to produce 1 pound of gain. Other lambs fed the same rations under like conditions, but at regular intervals according to the usual practice, gained 2.28 pounds per head per week and required but 6.97 pounds of dry feed for 1 pound of gain. Similar results were secured in a like test at the Minnesota Station. It may be stated that while fattening lambs by means of a self feed can be successfully done, it is an expensive practice and better results can be obtained by closer attention to the variations in the appetites of the lambs than the self feed permits.

Shearing Sheep When Fattening—It is often claimed that if sheep are shorn while they are being fattened they make more and better gains. At the Wisconsin Station when the lambs were shorn early in the season—October—they made more rapid gains for the next 6 or 7 weeks or until the wool reached a length of 1 or 2 inches, and at a slightly cheaper rate than unshorn lambs. But when the fattening period extended over a period of 3 or 4 months there appeared to be no practical advantage whatever in fall shearing, the unshorn lambs making as good gains in the long run as the shorn lambs and the increased length of the wool fiber counterbalancing in value the slightly greater weight of wool from the lambs sheared both in the fall and in the spring.

At the South Dakota Station lambs that had been fed 16 weeks and were ripe for market were shorn and fed heavily for 4 weeks longer. Practically no return whatever was obtained for the grain fed, and consequently all the food, labor and risk involved in keeping the sheep during this extra period was a total loss. Feeders are cautioned against attempting to get profitable gains out of sheep after they are finished, by simply taking off their fleece. At the Michigan Station where lambs were fed for 13 weeks, then sheared and kept in a warm barn for 3 weeks longer, they made slightly increased gains, but in another test when they were sheared in December and fed till the latter part of February, they suffered considerably from cold, required a half more feed to make a pound of gain and made less total gain than unshorn lambs.

These experiments indicate that early shearing in October may be a beneficial practice to prepare lambs that are 6 months old for the early winter market, but there appears to be no advantage in shearing them at any other period.

Fattening Sheep—Under this heading will be considered the winter feeding of lambs born the preceding spring, and older sheep. Before taking up the detailed work of the stations along this line with various feeds and feeding stuffs, some of the more general facts bearing on sheep feeding may be briefly mentioned.

The bulk of the lambs fattened in winter have never received any grain. This should, therefore, be fed them at first only in very small amounts. Beginning with 1-10 of a pound per head per day, the amount may be gradually increased to a pound a day in 4 weeks and to 2 pounds in 8 weeks with the mutton breeds. The rule is to feed the sheep all they will possibly eat and maintain a good appetite and not get off feed. If the lambs are overfed once it sometimes takes 6 weeks or more before they get back to making profitable gains again. As the temperature lowers, the rations may be increased, but should be decreased again as soon as warmer weather appears. In Colorado and some other Western States where range lambs are fed, and alfalfa is used as a forage, the grain ration seldom exceeds 1 pound per head per day at any time during the fattening period. At the Colorado Station it required about 400 pounds of alfalfa and 120 pounds of grain to put range lambs in good condition for the market. In general it takes about 400 pounds of hay and 500 pounds of corn to produce 100 pounds of gain with sheep. It takes from 12 to 16 weeks' good feeding to fit lambs for the market. If the feeding has been well done the lambs, at the end of this period, will be "ripe" for market. That is, they will be so fat and well filled out that further gain cannot be made at a profit. In a test at the Minnesota Station it cost 4.17 cents to make 1 pound of gain at the beginning of the feeding test and 23.17 cents at the end. At the North Dakota Station 19 sheep were fed a heavy grain ration for 4 weeks after they were "ripe." They gained but 5 pounds during the whole period, thus showing that any feeding done after the lambs are "ripe" is done at a loss.

With proper feeds and under good conditions, lambs will gain about ¼ of a pound per day, or from 25 to 30 pounds in 14 to 16 weeks. It requires 8 or 9 pounds of dry matter to produce 1 pound of gain with lambs and from 30 to 40 per cent more with older sheep. At the Iowa Station with 7 of the pure mutton breeds it required 8.53 pounds of dry matter, costing 2.96 cents, to produce 1 pound of mutton. The gain with these sheep averaged .53 pound per day per head. With 443 range lambs fed 108 days it required on the average 10.45 pounds of dry matter to produce 1 pound of gain. The gain per day was but .24 pound per head, or only about half as rapid as with the mutton breeds.

Sheep make cheaper gains and can generally be fed at a greater profit than cattle. At the Iowa Station lambs ate 48 per cent more per 1000 pounds live weight than growing cattle and gained 75 per cent more. Foreign experiments confirm these results. For comparison of sheep, cattle and pigs as regards the quantity of different feeds required to produce a pound of gain see under *Feeding Farm Animals.*

Rations for lambs must be palatable and suited to growth as well as fattening or else the lambs will not continue to eat vigorously, and without a vigorous appetite they cannot be fed with profit. The chemical composition of the ration is not of so much importance as its palatability. The best eaters in the flock make the largest and cheapest gains.

Alfalfa, Alsike, Clover, Cowpeas for Sheep—The best forage for fattening lambs in the East is red clover hay and in the West alfalfa. Feeding tests at the Montana Station resulted in placing alsike clover ahead of either of these hays for fattening lambs, but the range of growth and yield of this crop is not so great as either alfalfa or red clover. Lambs fattened on clover alone without any grain whatever at the Montana station gained 8.1 pounds per head per month. At the Ontario Agricultural College clover and alfalfa possessed about equal feeding values for sheep. At the Nebraska Station lambs fed alfalfa hay and grain made 52 per cent better gains than like lambs fed the same grains and prairie hay. When sorghum was substituted for prairie hay the lot fed alfalfa made 72 per cent better gains. In these tests the lambs on both prairie hay and sorghum were fed at a profit. At the Wyoming Station, where alfalfa was compared with native hay as a roughage for fattening lambs fed like grain rations, the lambs on alfalfa made 25 per cent better gains than the lambs on native hay. Stated in another way, an acre of native hay produced 476 pounds of mutton, while an acre of alfalfa produced 1756 pounds. Alfalfa hay also gave about 40 per cent better results at the Montana Station than a grain hay made up of a mixture of equal parts wheat, barley, oats and peas cut in the milk stage. The latter hay, however, proved but little inferior to clover for fattening purposes. Cowpeas are the great leguminous crop of the South and in that section of the country take the place of alfalfa and red clover. The experiment stations have reported but 1 feeding experiment with sheep with this crop, in which at the West Virginia Station it was shown to be much superior to timothy.

Corn Fodder, Bean Straw, Oat Straw, Timothy, etc., for Sheep—Next in value to the leguminous forage crops mentioned above stands cut corn fodder. It makes the best fodder and furnishes the most grain if cut when the grain is beginning to dent and the lower leaves are beginning to turn color. In experiments at the Utah Station well-cured fodder corn cut up before feeding, gave equal or better gains with sheep than corn silage and the flesh produced on the fodder corn was not so watery. For breeding ewes cut corn fodder proved superior to either corn silage, oat straw or bluegrass hay at the Wisconsin Station. In another test, however, corn silage proved a cheap and very satisfactory feed for breeding ewes.

Timothy hay and good oat straw had about the same feeding value in feeding experiments with sheep at the North Dakota Station. The gains on timothy and grain were at the rate of 2¼ pounds per head per week and on oat straw and the same grain mixture 2⅛ pounds per week. At the Michigan Station a number of forage plants were successfully substituted for clover hay in fattening experiments. Cheap and substantial gains were made on all of the following roughages: millet hay, oat straw, bean straw, cornstalks and alfalfa, mentioned in the increasing order of their value as substitutes. Care had to be observed in feeding the millet hay, at it induced scours.

Silage and Roots for Sheep—These crops add succulence and palatability to the ration and are greatly relished by sheep. In England sheep are largely fattened on roots and grain, and roots are grown in enormous quantities for this purpose. In this country corn silage is used to a greater extent than roots. Clover and other silage (see *Silage*) is also fed to some extent.

Tests at the Massachusetts State and New York Cornell Stations indicate that with sheep 4 pounds of corn silage are about equivalent in feeding value to 1 pound of hay (mostly clover). In tests at the New York Cornell Station with hothouse lambs, a lot receiving all the roots (long red mangel-wurzels) it would eat in addition to other feeds, gained on an average 3.44 pounds per head per week, while another similar lot given all the corn silage of good quality it would eat gained 3.85 pounds per head per week.

At the Michigan Station in a test of corn silage vs. sugar beets for fattening lambs fed alike in other respects, the gains per lamb on silage averaged 2½ pounds per week and on sugar beets 3 pounds per week. In another test good corn silage was fed against cut rutabagas for fattening lambs. The gain was the same with both lots, 1.7 pounds per week, but the root-fed lot made a profit of only 22 cents per head, while on the corn silage the gain was 63 cents per head. At the Ontario Station lambs fed roots with hay and grain gained 2.12 pounds each per week as compared with a gain of 1.8 pounds per week when silage was fed with the hay and grain.

Experiments at Wye in England indicate that sugar beets were not as good as mangels for fattening sheep. The wool of the sheep fed mangels was also better than the wool of sheep fed sugar beets. The English Board of Agriculture also reports 2 experiments in which mangels proved 20 to 30 per cent better than sugar beets in producing gains and it cost less to grow the mangels.

In a test of succulent vs. dry rations for fattening lambs at the Wisconsin Station, a lot fed on hay and grain alone gained 2.6 pounds per head per week. When silage was added to the ration the weekly gains were 2.3 pounds per head and when roots were added 2.4 pounds. The flesh of the lambs analyzed 49.39 per cent water for the lot fed roots, 43.84 per cent for the lot fed silage and 43.11 per cent for the lot on hay and grain alone, thus showing that succulent rations tend to the production of a watery flesh. At the New York Cornell Station in a feeding test lasting 4½ months, lambs on hay and grain gained 24.8 pounds per head. When corn silage was added to the ration the gains were 26.5 pounds per head.

So far as these tests go they would seem to indicate that silage has no special virtue over cut dry feeds for sheep, and that it is about equal in feeding value to roots, but very much cheaper than roots and most dry fodders.

A test was made at the Minnesota Station of the relative feeding values of mangels, sugar beets and potatoes for fattening range lambs. The lambs were fed like grain rations of corn, barley and oil meal and hay and all the roots they would eat in addition.

Each lot of lambs ate about 3½ pounds of roots per day. At the end of 110 days the lot receiving potatoes had gained 32.9 pounds; on mangels, 30.6 pounds, and on sugar beets, 34.6 pounds. These results are slightly in favor of sugar beets and potatoes. The relative high cost of the potatoes, however, makes their use much less profitable than either of the other roots.

At the Utah Station a lot of lambs fed roots (beets and turnips) gained 17 pounds per head in 3 months, while another lot fed the same ration without roots gained but 10 1-3 pounds. The flesh of the root-fed lambs analyzed 49.48 per cent water, while the flesh of the other lot contained but 40.77 per cent of water—results which are concordant with those reported from Wisconsin above.

At the Colorado Station sugar beets fed in small quantities in connection with a grain ration slightly increased the gains and made a return of about $3 per ton. Fed all the sheep would eat or above 4 pounds per day, they returned but $2 per ton, an amount too small to pay for raising them. In other tests as good gains were made on sugar beet pulp with grain and alfalfa hay as on sugar beets. The pulp is 90 per cent water. A ton proved equivalent in feeding value to 200 pounds of corn. Owing to its bulky nature lambs cannot consume enough in the later stages of fattening to finish off well, hence it is of greatest value in the early stages of feeding. During the finishing off period it should be fed only in small amounts to regulate the bowels. Fed in large quantities it produced a soft flesh and in shipping many lambs were crippled.

At the Maine Station it was found that the dry matter in roots (rutabagas) has no special and peculiar value beyond the small quantity which it may be wise to feed for the purpose of giving variety to the ration. Roots added to a grain ration gave 70 per cent better gains at the Minnesota Station than the same ration without roots and the net profit was considerably larger.

These experiments would seem to indicate a high feeding value for roots, on a par at least with corn silage for fattening purposes. When it is considered that sugar beets fed in quantities greater than 4 pounds per head per day induce scouring and that the cost of production is considerably greater than most other roots and than corn silage, it would seem that in regions where corn can be grown it is sound business policy to put up corn silage for sheep rather than grow roots, since it can be grown much cheaper and preserved better than roots or almost any other silage, is palatable and conducive to good gains.

Grains for Sheep—Many experiments have been carried out by the experiment stations with the different grains for fattening sheep. Some of the more important of these will be noted below.

Barley—There are 2 kinds of barley, common and bald. The bald barley contains an unusually large amount of protein as compared with common barley. At the Colorado Station, where these 2 barleys were fed to fattening lambs in comparison with other grains, slightly more gain was made on bald barley than on corn. The lambs, however, were unable to eat more than a pound per head per day without getting off feed. Common barley produced about the same gains as wheat but did not quite equal corn. Whole barley gave better results than ground barley.

In feeding range lambs at the Minnesota Station, barley, corn and oats were about equally valuable in producing gains. Lambs at the North Dakota Station gained 2¼ pounds per head per week when fed on a ration of 3 parts barley and 1 part bran with timothy hay. At the South Dakota Station lambs receiving barley as the only grain ration gained 2.53 pounds per head per week, consuming but 5.09 pounds of grain to make 1 pound of gain.

These experiments rank barley among the best farm grains for lambs. Owing to its comparative richness in nitrogenous material it is adapted to growth as well as fattening and therefore is one of the best grains for feeding lambs in the early stages of fattening. (See also *Barley.*)

Corn—Corn is King of the grains in the final stages of fattening sheep. It should be fed whole except to old sheep and to lambs before weaning. For fattening, corn is the standard by which other grains are measured. It is the cheapest grain and the one produced most abundantly in this country. It is not so safe to feed as a single grain ration and in large quantities as some of the other grains, since it is liable to occasion various digestive disorders in the flock and they easily get off feed on it, but figured at 30 cents per bushel, no other grain or combination of grains produces gains as cheaply with lambs either before weaning or after weaning or in feeding older lambs or sheep. In a series of experiments extending over a number of years at the Wisconsin Station, greater, but more costly gains were made on corn and peas mixed. In a comparison of corn and wheat at the Colorado Station the wheat gave a better growth in the early stages of feeding than corn, but later better gains were made on corn. The station believes it best to feed wheat the first third of the winter, then half wheat and half corn for the next third, finishing off on clear corn. In fattening older sheep corn is considered by far the best grain to feed. (See also *Corn.*) At the Iowa Station corn at 33 cents per bushel was a more economical grain to feed to sheep on grass than oats at 23 cents or barley at 40.

Emmer is considered below under *Spelt.*

Kafir Corn—Not many data have been accumulated on the feeding value of Kafir corn for sheep. At the Oklahoma Station a wether lamb fed 2 pounds of Kafir meal a day with crab grass hay gained 13 pounds in 4 weeks. On the same ration a Shropshire ram gained 17 pounds in the same time. Again 3 wether lambs and 3 rather inferior yearlings were fed Kafir grain for 52 days and made an average gain of 2.87 pounds per head per week, requiring 5.82 pounds of grain for each pound of gain. These tests show a very high feeding value for Kafir corn grain. (See also *Kafir Corn.*)

Oats—On whole oats and timothy hay at the North Dakota Station lambs gained 2½ pounds per head per week for 8 weeks. At the Minnesota Station, where oats were fed with corn, bran and hay to lambs, 36 per cent better gains were made than when oats were omitted from the ration. The total amount of grain consumed was the same in each case. Oats usually are too expensive to constitute the whole grain ration for fattening sheep. Added to corn they give variety and palatability to the ration. The grain is more nearly like wheat and barley in composition and is therefore better adapted to growth than fattening. Sheep make good gains on oats and an excellent quality of mutton, and when they are cheap enough they may be profitably fed. Ordinarily they should constitute only part of the grain ration for fattening sheep. For breeding ewes or in the production of wool they make one of the best grain rations.

Peas—Canada field peas make an excellent growing ration for lambs and when fed in equal parts with corn have produced 20 per cent better gains with older lambs at the Wisconsin Station than corn alone or corn and oats. Sheep relish them and the quality of the mutton made on them is of the very finest. On peas and oats at the Ontario Agricultural College, lambs gained 2.10 pounds per head per week and on corn and oats 2.29 pounds. In another test a lot of lambs fed corn alone gained 2.52 pounds per week; peas 2.91 pounds per week, and equal parts corn and peas 2.6 pounds. The grain consumed per pound of gain was 3.8, 3.3 and 3.68 pounds respectively.

Screenings—When wheat is cleaned at the elevators enormous quantities of screenings, consisting of broken wheat kernels and shrunken grains, weed seed, chaff, etc., accumulate. At the Minnesota Station when corn was worth $13 per ton for fattening sheep, screenings, consisting of about 90 per cent small wheat grains and edible weed seed, was worth $10.35, wild buckwheat seed $9.56 and pigeon grass seed $9.40. These figures place the feeding value of screenings at any time at about ¾ the value of corn or barley. At the North Dakota Station lambs fattened on wheat screenings gained 2 pounds per head per week at a cost of 5.22 cents per pound of gain. At the Utah Station the gains on screenings for 3½ months varied from 1.44 to 1.68 pounds per head per week.

Spelt or Emmer—This grain was found by the South Dakota Station to have a feeding value for fattening lambs 2-3 that of barley. Lambs fed all the hay and spelt they would eat gained 1.67 pounds per head per week for 3 1-3 months. Estimating corn at 82 cents per hundred pounds, spelt had a feeding value for sheep of 76 cents per hundred pounds. In another test with sheep on grass it required twice as much spelt as corn to produce a pound of gain and a third more spelt than barley, oats or wheat to produce a pound of gain.

At the Iowa Station spelt pound for pound proved practically as valuable as corn for fattening wethers. At the Colorado Station spelt proved cheaper pound for pound than corn and resulted in larger gains than corn for fattening lambs.

Wheat—Tests in Colorado, Michigan and at other experiment stations show that wheat is about 10 per cent less valuable than corn for fattening lambs. It conduces to growth and is therefore well adapted to feeding in the early stages of fattening. At 50 cents per bushel it is more profitable to feed wheat than sell it. Frosted wheat, or unmarketable, shrunken wheat seems from tests in Utah to be fully as valuable for fattening purposes as good marketable wheat. Macaroni wheat, either ground or whole, proved as good a feed for lambs as common bread wheat and nearly as good as corn in experiments at the South Dakota Station.

Miscellaneous—Wheat bran has not given very good results in fattening except when fed in small amounts with some other grain. It is too bulky and produces growth rather than fattening. Oil or linseed meal fed in small quantities with other grains seems to increase the appetite and consuming power of lambs fed on it. When lambs were fed 1 part oil meal and 2 parts corn meal with pasture they gained 3.3 pounds per head per week. When cottonseed meal was substituted for the oil meal in this ration the gain was 2.95 pounds per week. Even at $27 per ton one station found it profitable to feed a small amount of oil meal to fattening lambs. The old and the new process linseed meals were found equally valuable for sheep by the Massachusetts Hatch Station. The State Station found that linseed meal, cottonseed meal and Chicago gluten feed could be substituted one for the other without materially changing the cost of the ration or its feeding value. Buffalo gluten feed and Chicago maize feed were also interchangeable.

The amounts in pounds of different grains required for 100 pounds of gain in sheep as determined by a large number of experiments, are shown in the following table:

Barley	Corn	Kafir corn	Oats	Peas	Wheat	Mixed grains
453	502	582	518	422	582	454

Hothouse or Winter Lambs—These are lambs born in late fall or early winter and forced into rapid growth for 9 to 12 weeks or more, when they are killed and sent to market. The ewes are fed such grain, hay and succulent rations as will conduce to the largest flow of milk during this period and the lambs are induced to eat grain as early as possible. The New York Cornell Station states that a little sugar sprinkled on ground feed will help materially to teach the lambs to eat. The grain should be placed in a lamb creep within easy reach of the lambs at all times and where it cannot be disturbed by the ewes. Different kinds of ground feed are readily eaten, but corn and oats are especially relished. Whole wheat, cracked peas and whole oats are also readily eaten. In a comparison by the New York Cornell Station of pure bred Shropshire and Dorset sheep as breeds to produce hothouse lambs, the Shropshire lambs averaged 9 11-16 pounds in weight at birth and 42¾ pounds per head 9 weeks later, thus making a weekly gain of 3.91 pounds per head. The Dorset lambs averaged 10 9-16 pounds at birth and 53.5 pounds per head when 9 weeks old, making an average weekly gain of 5.36 pounds per head for the whole period. When the experiment was repeated the following year the average weekly gain for Shropshire lambs for 12 weeks was 2.87 pounds and for the Dorset lambs 4.47 pounds. In both tests the lambs of both breeds were given all they would eat. The Dorset ewes ate more food than the Shropshire ewes, stood forced feeding better and were less affected by changes in the weather than the Shropshires.

In another test grade Shropshire and grade Dorset ewes were used. The lambs from the grade Shropshire ewes made an average weekly gain of 2.66 pounds per head for 12 weeks and from the grade Dorset ewes 3.64 pounds, showing again the advantage of Dorset blood in ewes for producing rapid growing lambs.

At the Colorado Station Shropshires crossed on Merinos were compared with Dorsets crossed on Merinos for producing early lambs. In 3 years 25 Shropshire grade ewes produced 61 lambs which dressed 26 pounds each when 84 days old and sold for $3.64 per head, or $224.15 for the whole number. The 25 Dorset crosses produced 74 lambs during the same period which dressed 25 pounds each when 84 days old and sold for $3.57 per head, or $264.05 for the whole number. This shows a balance of $39.90 in favor of the Dorset grades, due entirely in this case to the increased number of lambs produced.

One of the difficulties in growing winter lambs is to get the ewes to breed early enough. Experiments at the Wisconsin Station in crossing grade ewes with a pure Dorset buck indicate that the characteristic of the Dorset ewes to breed fully 3 months earlier than the other breeds is transmissible through the male line to the first cross, and more strongly still to the second cross of the Dorset on the first cross-ewe. "This suggests an economical and commendable method of establishing a flock for breeding early lambs."

Grain Alone for Sheep—At the Utah Station sheep were fattened on grain and beets without any other coarse fodder whatever. At first the sheep decreased in weight, but gradually picked up, and for 4 months gained .17 pound per head per day. When killed at the end of this period the sheep were very fat and the mutton tender and well flavored.

Milk for Lambs—Lambs at the Wisconsin Station made nearly as good gains when fed skimmilk as young pigs do on this feed.

Soiling Sheep—Ten ewes and 10 lambs were fed green food in the barnyard at the Wisconsin Station one summer. In 57 days the ewes gained 55 pounds and the lambs 192 pounds. A pound of gain was made at a cost of 3.66 cents. The returns for the clover were at the rate of $24 per acre and for the corn $30.

At the Utah Station one lot of sheep which ran out to pasture gained 9.2 pounds per head per week. Another lot fed fresh timothy hay in the barn gained 12 pounds, and a third lot fed green timothy in the barn gained 15 pounds. These results show that soiling sheep can be successfully accomplished. They are rather dainty, however, about eating long grass which has been handled much. The sheep much prefer to gather their own food, and in doing so will destroy many weeds. The practice of soiling sheep cannot be advised.

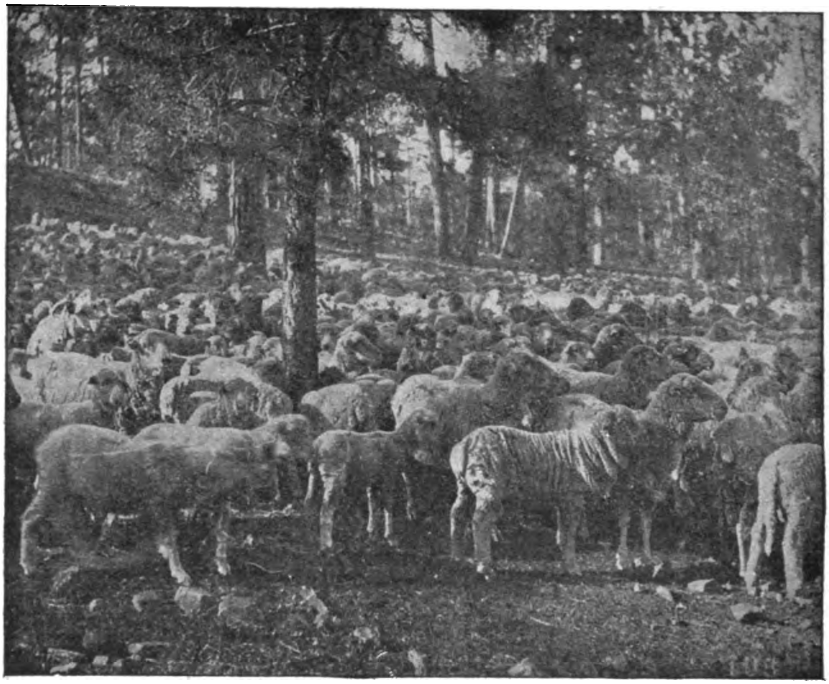


Fig. 406—SHEEP GRAZING IN WOODS
(From U. S. Dept. Agr. Yearbook 1901)

Tying Up Wool—Wool fleeces should be lightly rolled together, and tied with light, strong string, using as little as possible, but sufficient to hold the wool together. Coarse, heavy twine should never be used. No. 18 hemp twine and small linen twine are very satisfactory. The Michigan Station found that Michigan wools of equal grade sold considerably below Ohio and Pennsylvania wool largely on account of the old square method of doing up the fleece and tying it with heavy, coarse sheep twine. If square boxes are used they should be much larger than those in general use and smaller and much less twine used. Loose, bulky fleeces sell best in the market.

At the Iowa Station wool was kept for about a year in (1) a tightly closed box, (2) in a sack suspended from the ceiling, and (3) wrapped in paper and placed on a shelf. Practically no shrinkage in weight occurred in any of the fleeces.

Range Methods of Sheep Raising—In the Rocky Mountain and Pacific Coast States, where sheep raising is conducted on a large scale, the methods of managing sheep are far different from those commonly in use in the Eastern States. Each sheep raiser owns from 4000 to 100,000 sheep. They are divided into bands or herds of from 2000 to 3000, under the constant care of a herder, who has 1 or 2 dogs to assist him in controlling the sheep. The sheep obtain sufficient forage a greater part of the time by grazing on the open range, and in many localities they are successfully managed on the range for the whole year without the necessity of feeding hay at any time. This is especially true in the Southwest, and even in parts of Wyoming and Montana, where sufficient forage for sheep is found on the mountains during the whole year. Under these conditions it costs from 75 cents to $1 per head annually to care for the sheep. The grazing ground at the disposition of each sheep owner is divided into a summer and winter range. During the winter and spring until after shearing and lambing time the sheep are kept conveniently near to the ranch house. In summer they are driven into the mountains, where they graze until forced out by the mountain snowfall of the late autumn. (Fig. 406.)

During lambing season a lambing wagon is kept in attendance on each band of ewes, and the lambs and ewes are picked up and taken to lambing sheds as soon as the lambs are born. Here the ewes and young lambs are kept in small herds of from 25 to 50 until the lambs are a few days old and have been "owned" by their mothers. When the lambs are from 10 days to 2 weeks old they are docked and marked. The various operations connected with the management of sheep take place at different times in different States. The professional shearers are busy the year round, operating in South America and Australia during our winter season and beginning shearing in this country in the extreme Southwest early in the spring. From this point they gradually work northward, and the shearing season ends in Montana about July 25. Expert men easily shear 100 sheep per day, either with hand shears or with the shearing machines. Exceptionally good men shear 200 or more per day. The machine shearing plants are of various sizes, accommodating from 10 to 40 men, and are gradually displacing hand shearing in many parts of the country. The chief advantages of machine shearing are a smoother cut of the fleece and a somewhat larger clip. It is estimated that from ½ pound to 1 pound more for each fleece is obtained by shearing by a machine.

The surplus of old sheep and lambs is usually sold each year for mutton. These are either shipped East immediately without any attempt at fattening, or they may be fattened before shipping. The usual feeding materials for this purpose are alfalfa and roots.

The sheep men of the Northwestern States at present prefer a crossbred sheep bearing wool of medium fineness. Usually an attempt is made to secure a general purpose sheep. Coarse wool bucks, either Cotswold or Lincoln, are used for about 2 seasons, and then in order to prevent the wool becoming too coarse a change is made to fine wool bucks of some Merino breed, of which the Rambouillet is at present in great esteem. Each fleece is tied up with twine and the fleeces are then put in wool sacks, being packed as firmly as may be done by the tramping of a man employed for this purpose. The weight of the full sacks averages about 400 pounds.

Diseases—For an account of the medicines and of the doses mentioned under the diseases below see *Veterinary Medicines*.

SCAB is a contagious disease due to the scab mite (*Psoroptes communis* var. *ovis*). The mite punctures the skin of the sheep to obtain its food and thus produces an itching and irritation which finally results in the formation of pustules. From these pustules a fluid exudes which in drying forms scabs, under which the mites live. As the mites multiply they move out from the center of infestation and establish themselves upon healthy skin. The irritation produced by the presence of the scab mite renders the sheep restless. They bite and pull the wool from affected areas, rub against fences and brush against other sheep. The tendency to rub against various objects is one of the first symptoms of sheep scab. Soon a loose lock of wool is seen projecting from some place upon the back or side of the sheep. The scabby area increases in size and a bare spot of greater or less extent is exposed. The mites gradually spread over the body until all the skin of the upper part is scabby. Affected animals usually die unless treated. An advanced case of scab is seen in Fig. 407.

Experiments have shown that scab mites may live from fall to spring or from spring to fall in the soil of infested localities without obtaining any nourishment from sheep. Eggs kept at a temperature near that of the body hatch in about 4 to 8 days.

The most satisfactory method of curing scab consists in dipping the sheep in some liquid which will kill the mites. A vat constructed like the one shown in Fig. 408 greatly facilitates this work. Experiments have been made with a large number of dips for this purpose, including California dip, Fort Collins lime and sulphur dip, Skabcura, Australian dip, tobacco decoction, arsenite of soda, carbolic acid and corrosive sublimate, kerosene emulsion, whale-oil soap, etc. The Fort Collins lime and sulphur dip (lime 11 pounds, sulphur 33 pounds, water 100 gallons) gives fairly good results. Equally effective is the California dip (sulphur 100 pounds, lime 25 pounds, water 100 gallons). A number of other dips containing lime and sulphur have been recommended and used with satisfactory results. A prejudice exists to some extent against lime and sulphur dips, but this prejudice has been largely encouraged by the agents of patented dips. Various tobacco dips have been recommended on the ground that no injury results to the wool from their use. Skabcura is in quite general use in the Western States and has proved very effective. In some experiments it is found that there is a loss of about ¾ of a pound per head during the week following the dip. This loss, however. depends largely upon the temperature and manner in which the sheep are handled. There is no evidence to substantiate the claim made for some proprietary dips that they have a tonic effect upon the wool. Recent observations in Bradford, England, show that the arsenical dips are less apt to injure the wool than either tobacco or lime dips.

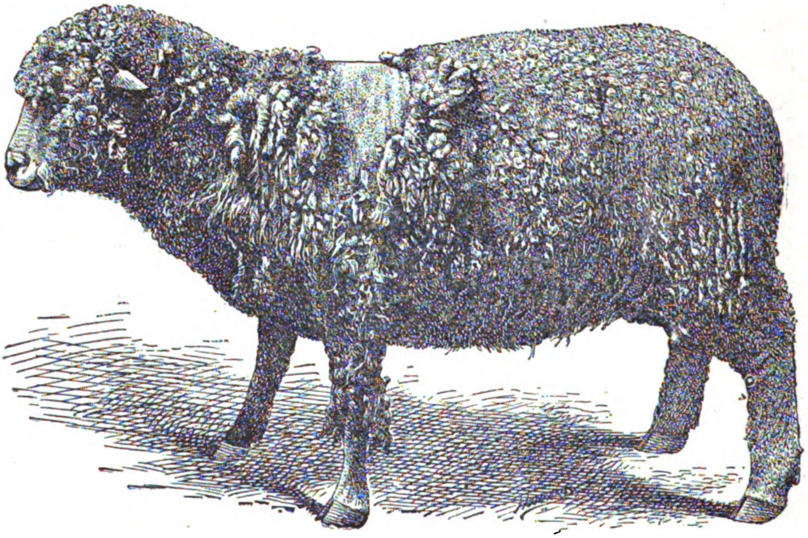


Fig. 407—ADVANCED CASE OF COMMON SCAB
(Bureau Animal Industry)

A second dip should be given about 10 days after the first in order to destroy mites which may have hatched from eggs which were present at the first dipping. In some badly infested localities it is necessary to dip the sheep once or twice annually without waiting for the appearance of scab.

For preparing the lime and sulphur dip slake 11 pounds of lime in water enough to make a thick paste. Sift into this 33 pounds of sulphur and mix thoroughly. The weights should be determined accurately and not guessed at. Place the mixed paste into a kettle with 25 to 30 gallons of water and boil for 2 hours; then pour the whole mixture into a barrel and allow it to settle. The barrel should have a bunghole about 4 inches from the bottom. After the sediment has settled the clear liquid should be drawn off and diluted with water so as to make 100 gallons.

In preparing the tobacco dip use about 21 pounds of leaves to 100 gallons of water. The tobacco should be soaked for 24 hours and then brought to the boiling point for a short time. The extract may then be removed by pressure and added to the proper amount of water. (U. S. Dept. Agr., Bureau of Animal Industry Bul. 21; Colo. Expt. Sta. Bul. 38; S. D. Expt. Sta. Bul. 36.)

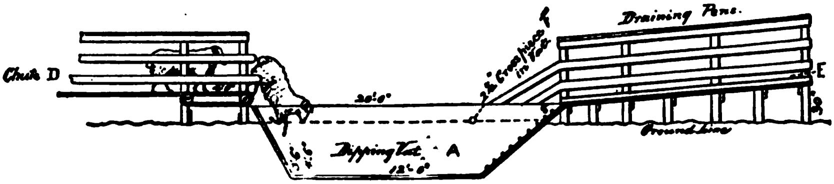


Fig. 408—DIPPING VAT
(U. S. Dept. Agr.)

Head Scab is a disease caused by a parasitic mite (*Sarcoptes scabiei* var. *ovis*). This mite is the cause of itch or mange, and there are a number of varieties which infest other animals, producing similar diseases upon them. The attacks of the mite are mostly limited to the head, beginning usually on the upper lip and extending backward about the eyes, ears and other parts of the body which are only partly covered with wool. The mites burrow under the skin and cause the formation of pustules, which become covered with a scab. One of the first symptoms of the disease is a constant rubbing of the head. Almost any of the ointments or dips used by sheep men will check the disease if applied when it first appears. The scabs may be first removed by rubbing with oil before the main remedy is applied. Kerosene emulsion or tar sulphur oil ointment gives satisfactory results when used in this way.

Gid or Staggers is a disease caused by the immature stage of one of the tapeworms of the dog (*Taenia coenurus*), which becomes located on the surface of the brain and spinal cord of the sheep. The increased pressure produced on the brain and spinal cord by the presence of the capsules in which the worms are found causes the nervous symptoms which characterize the disease. The chief symptoms are persistent turning around, loss of appetite and emaciation. In cases where the tapeworm is located on one side of the brain, a tendency of the animal to turn its head to one side is more or less marked. Sometimes, when the worm is located near the top of the head, an enlargement of the skull over this point takes place, and the worm may be removed by an opening through the skull. The adult form of this tapeworm infests the digestive organs of dogs, wolves, coyotes and foxes, and the eggs escaping along with the feces are washed upon the stems and roots of the grasses, and thus may be taken into the stomachs of sheep, from which position, by boring their way through the tissues, some of them come to be located upon the brain and spinal cord. No medicinal treatment is of any value against the disease. When the worm may be definitely located it may be removed by trephining. In preventing this disease attention should be given to burning and burying the spinal cord and brains of sheep which have died of gid. Dogs should not be allowed in sheep pastures without treatment for tapeworms. Gid is fortunately not very prevalent in this country.

Foot Rot—In general 2 forms of this disease are recognized, the non-contagious and the contagious. Some veterinarians, however, consider them both the same, differing only in degree of virulence. The non-contagious form is believed to be produced by foreign substances between the hoofs, causing inflammation of the space between them. If this inflammatory process is not checked the whole foot becomes involved and the horny layer separates and falls off. The same result is sometimes brought about by moving sheep from high to low marshy pastures. Under such conditions the hoofs grow too long and offer better opportunity for the adherence of materials which cause inflammation and decay. Usually the front feet are worst affected. In treating this disease superfluous horn should be removed from the hoof, the foot should be cleaned thoroughly, and butter of antimony applied to the inflamed part. The application should be repeated in 24 hours if the wound is still discharging. The foot may be kept clean by washing with water containing blue vitriol 1 part to 12. One part of carbolic acid to 150 of water may be used for the same purpose. In the contagious form the cause is thought to be a virus which may be introduced into the flock in various ways from infected sheep. Lameness is noted in 1 or more feet. Affected feet will be found swollen above the hoof and the spaces between the claws will be red and sensitive, as shown in Fig. 409. The hoof drops off after a period of about a month and the disease spreads until all 4 feet are involved. Whenever the disease appears among sheep affected animals should be separated from the rest of the flock. The same treatment may be applied as that recommended for the non-contagious form of foot rot.

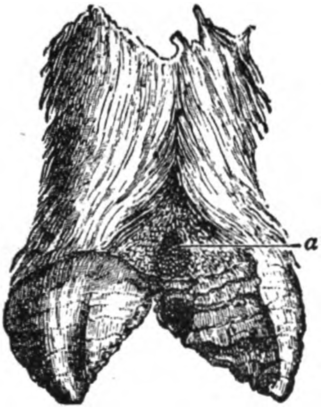


Fig. 409—FOOT ROT IN SHEEP

Parasitic Ictero-Haematuria, known also in Europe as carceag, is a disease due to a microscopic parasite which resembles the blood parasite of Texas fever. The parasitic organism is found in the blood, liver, spleen and kidneys. The disease appears to be peculiar to sheep. The first symptoms are a moderate fever and bloody urine. The membrane of the eyes and nostrils, and in some cases the skin also, becomes yellow. Dropsical swellings occur on the sides of the head and neck, and the animal remains in a crouching position during the greater part of the attack. Post-mortem examinations show a marked yellow color in the skin and fatty tissues and an enlargement of the kidneys. In this country the disease is apparently confined to certain localities in the Rocky Mountain States, especially Montana and Idaho. No experiments have been made with remedies, but in one instance goats have been substituted for sheep in an infested area, with satisfactory results.

Nodular Disease is an infection of the intestines caused by the presence of the parasitic worm *Oesophagostoma columbianum*. The disease cannot be diagnosed with certainty, except by post-mortem examination. Generally there is a profuse diarrhea and an anemic condition. Upon examining the intestines of affected sheep tumors will be found in the walls, and in the larger tumors of this sort a small round worm will be found, surrounded by the contents of the tumor. This is the immature form of the worm, the adult form being found in the large intestines. No treatment for this disease has been devised, but it is fortunately not of general occurrence.

Botfly (*Oestrus ovis*) resembles somewhat the common housefly, but is covered with small round spots. The abdomen bears velvety brown and straw colored hairs. The maggots of this species are of a white color, with brown spots on the posterior segment. The eggs are deposited by the adult fly within the nostrils of the sheep. After hatching, the larvae penetrate deeply into the nasal cavity, and after becoming full grown fall to the ground, where they bury themselves and finally emerge as adult flies. The maggots may sometimes be dislodged by means of a feather dipped in turpentine and inserted into the nostrils of the sheep. Fumigation by means of sulphur fumes and other irritating substances in closed rooms has proved injurious to the sheep and only partly effective for removing the maggots. Tar smeared about the nostrils of sheep has a tendency to prevent the flies from laying their eggs in them.

Lung and Stomach Worms are small round worms belonging to the genera *Strongylus* and *Pseudalius,* of which a number of species are found in the lungs and respiratory passages, while *S. contortus* is parasitic in the stomach. The parasitism of lung worms in the sheep is characterized by fits of coughing and sneezing, with a mucous discharge from the nostrils. The sheep stretch out the neck, rub the nose on the ground and give evidence of difficulty in breathing. Diarrhea is usually present. The wool becomes loose and the skin is pale, from which the popular names white-skin and paper-skin are derived. Lambs are most subject to the disease during the first year.

In case of parasitism of sheep by the stomach worm, there are digestive disturbances, accompanied by constipation and later diarrhea. The appetite is irregular and abnormal. The disease caused by lung worms is often known as verminous bronchitis and is most prevalent during years with a wet summer followed by a mild winter. As soon as an outbreak of the disease occurs, affected animals should be separated from healthy ones, and both should be placed on dry, uninfected pastures, free from pools of stagnant water. For the treatment of the disease it has been recommended that animals be driven into a closed shed and made to inhale chlorin gas or sulphur fumes as long as they can endure it. Calves are also subject to this disease and may be treated by inserting a hypodermic syringe between the rings of the windpipe and injecting a mixture of equal parts of turpentine and sweet oil, to which carbolic acid has been added in the proportion of 12 to 20 drops to a tablespoonful of the mixture. Two or more injections of this mixture made at intervals of several days give good results. Equally good results are obtained in the treatment of sheep for lung worms by injecting into the windpipe a mixture of 2 parts olive oil and 1 part turpentine, in doses of from 1 to 3 teaspoonfuls. Infestation by lung and stomach worms is apparently most frequent in wet pastures, especially those which contain foul and stagnant water.

In the treatment for the stomach worm of sheep a good remedy is 1 part of turpentine to 16 parts of milk, given in doses of from 1 to 3 tablespoonfuls, according to the size of the lamb. Better results are obtained from the use of a mixture composed of 8 parts pine tar, 8 parts raw linseed oil and 1 part turpentine, in doses of 1 to 3 ounces. Considerable importance should be attached to keeping lambs away from contaminated feed and water. Sometimes worm infection apparently comes through infested pasture grass. Recent experiments have shown that benzine and gasoline are perhaps the most effective remedies in treating this disease. One tablespoonful of gasoline and 4 ounces of sweet milk, shaken together, is recommended for a sheep weighing from 60 to 100 pounds. This treatment should be given only after a fasting period of from 12 to 18 hours, and no water should be given until after a further period of at least 2 hours. The treatment should be given for 3 consecutive days, and then repeated for the same number of days 1 week or 10 days later. At Biltmore, N. C., Wheeler had best results from the use of solutions of lysol and other coal tar products in doses of 6 ounces of a 1 per cent solution. (Ark. Expt. Sta. Bul. 35; Ohio Expt. Sta. Buls. 91, 117.)

Fringed Tapeworm (*Taenia fimbriata*) is the cause of extensive financial loss in sheep, especially in the Western States. When these worms are present in the intestines and bile ducts of lambs in large numbers, the lambs are weakened and fail to develop and put on fat. The general symptoms are those of malnutrition, and by some authors are considered nearly identical with the symptoms of loco disease. The worm produces first an irritation of the intestines, and their presence in the gall ducts produces similar results and obstructs the flow of bile. Vermifuge treatment is usually without very satisfactory results. It is best to withhold food from animals for at least 12 hours before administering remedies for expelling the tapeworms. Powdered areca nut may be given in doses of 1 to 3 drams, or powdered male-fern root or the ethereal oil of male-fern in dram doses.

Liver Rot is due to the presence of a flat worm which is parasitic in the liver, lungs, abdominal cavity, or rarely in the muscles of sheep, cattle, hogs and other domestic animals. The adult is found in the bile ducts of the liver, where it produces a great number of eggs. These eggs pass into the intestines, from which they are eliminated along with the feces. Such eggs as find their way into ponds and pools of water hatch and are parasitic in the body of fresh-water snails. After passing this immature condition they crawl upon the stems of grasses, from which position they may be taken into the stomach of sheep or other animals and attain again the adult condition in the liver of such animals. The symptoms of the disease produced by the liver fluke are not well defined. In sheep there is usually a redness of the eyes, which soon yields to a paleness and general bloodless condition, followed by emaciation and a rapid respiration. The mortality from this disease is high. It is frequently the cause of trouble in cattle, but is comparatively rare in hogs. The fluke disease is more prevalent in wet than in dry years. The use of drugs for the removal of flukes is of no avail. Tonics may assist a small proportion of animals to recover. Salt will kill the young flukes in the stage in which they are taken into the stomach of sheep, and it has sometimes been recommended that animals be given liberal quantities of salt for this purpose.

MALIGNANT OEDEMA, sometimes called gangrenous septicaemia, is a disease common to a number of domestic animals, including sheep, cattle and horses. The disease resembles blackleg rather closely and is sometimes mistaken for it. It arises ordinarily from injuries in the skin, and the first symptoms of swelling with the formation of gas bubbles in the tissues occur at the point of injury and gradually extend to the neighboring parts. The disease develops in almost every case within from 24 to 48 hours. In sheep, outbreaks of the disease sometimes occur in consequence of cutting the skin at shearing time. It appears that shearing pens, in which the disease develops under such circumstances, may become permanently infected, and it is desirable, therefore, to abandon such pens and build new pens in a new locality. The danger of spreading this disease by sheep shears may largely be avoided by washing all the instruments in antiseptic solutions.

SHEEP TICK (*Melophagus ovinus*) has frequently been considered of little importance as an enemy of the sheep. This insect is a peculiar fly, without wings and with only 6 legs, differing in this respect from the true ticks, which have 8. The sheep tick is really the cause of serious losses among lambs in many localities. After the ewes are shorn the ticks migrate at once to the lambs and cause great irritation and loss of flesh. It has been found necessary in many localities to dip the whole flock, including lambs, immediately after shearing, in order to get rid of this pest. For this purpose sheep may be dipped in the same solutions as used for sheep scab.

GOAT

Common goats have long been familiar objects about farmyards and in the outskirts of cities, but they have multiplied to an extent which is not generally realized. According to the most recent census statistics on this subject, there are 1,815,000 goats in the United States, of which only about 500,000 are Angoras, the remainder being common goats.

Angoras were introduced into this country from Turkey about 1850, and have been bred ever since in different parts of the country in small numbers. It is only within the last few years that the goat industry has assumed especial prominence. Goats are useful for several purposes. Their skins are used in the manufacture of leather, or for rugs; the fine hair of Angoras is known as mohair, and is used in the manufacture of various dress goods and plushes. The demand for mohair in manufacture in the United States is much in excess of the supply which can be obtained from goats in this country, and a good market for this product may be expected for a long time to come. The meat of common goats, and especially of Angoras, is eaten to a large extent, being commonly sold under the name of mutton, and more recently bearing the name Angora venison, or Angora mutton. If the goats are well dressed it has perhaps a more delicious flavor than mutton and seldom has as much fat. In certain localities the meat is at present sold, under the name of Angora mutton, for prices slightly higher than those paid for sheep mutton. The meat of the Angora goat is preferable to that of common goats. A venison-like flavor is given to goat meat when the animals browse upon various wild shrubs. This gamy flavor, however, is not so noticeable when the animals are fed upon cultivated plants. Very little use is made of the milk of goats in this country, but analyses show it to be of high nutritive value, and it can be used in the manufacture of cheese.

The presence of Angoras or other goats in bands of sheep is a source of protection to the sheep, since goats will defend themselves and the herd against attacks of dogs or coyotes. A fine specimen of an Angora buck is seen in Fig. 410.

Goats readily adapt themselves to a great variety of conditions. High and dry land, however, is the most suitable for goat pasture. In lowlands they are much subject to foot rot and lung worms, and for this reason the raising of goats may become unprofitable, or even impossible, in many of the low, wet regions of the Eastern States. Already many complaints have been made of the great prevalence of lung worm disease among goats. In the high grazing ground of the Rocky Mountains and Pacific Coast region the best conditions for goat raising are found. Here the climate is exceedingly dry, and as a consequence the animals are not subject to foot rot or lung worms—in fact, neither of these diseases is at all common in that region among sheep or goats. Goats seem to require more exercise than sheep and naturally travel greater distances than sheep. Their feeding habits on the range are considerably different from those of sheep, since they seem to prefer brush, briars, weeds and coarse fodder, which is seldom eaten by sheep or cattle. For this reason they are considered especially useful in clearing off brush-covered areas, where the expense of such clearing would be perhaps greater than the value of the land if done by man. The common and Angora goats are equally good for this purpose. On account of their feeding on brush and the bark of trees to such an extent, they are a nuisance in forest reserves where the preservation of seedling trees is desirable.

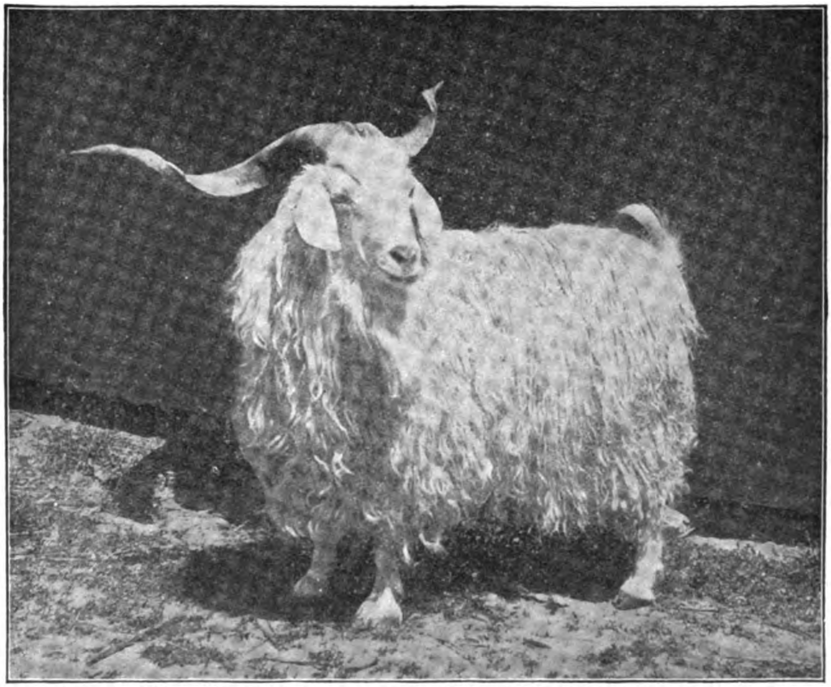


Fig. 410—ANGORA BUCK

In the Eastern States the care and management required for goats is essentially the same as for sheep. In the Western States they may be managed in bands of from 2000 to 3000. When allowed to graze upon the open range they travel faster and farther than the sheep, and therefore furnish more trouble to the herder. For this reason it is necessary to keep the kids in corral during the day until they are a week or 10 days old, since they could not keep up with the does. After that time they may be allowed to run together. The kids should be weaned at the age of about 5 months. Angoras may be sheared by hand or with machines, in the same manner as sheep are sheared. In the Northwestern States they require only 1 shearing a year; in the South it is necessary to shear them twice during the year, since otherwise a portion of the fleece is lost by shedding. Goats, as already indicated, are more active than sheep and are able to maintain themselves easily under conditions which are favorable to sheep raising. In situations where sheep can obtain forage from the range during the whole year, goats may be depended upon to maintain themselves in good condition without feeding. It will be necessary, however, to feed under the same conditions which render it desirable in the case of sheep.

As a rule goats are less subject to diseases than sheep, with the exception of foot rot and lung worms. In 1 or 2 locations in the Western States goat raising has been resorted to on account of the fact that disease had made the sheep business unprofitable. As already stated, however, goats seem to be very subject to attacks of lung worms, and on low wet lands it would seem undesirable to venture into goat raising until preliminary experiments had been tried on a small scale. Recently also a very fatal, contagious disease known as takosis has appeared among goats. The chief symptoms are great weakness, emaciation, diarrhea and pneumonia. No medicinal treatment is effective. Dr. Mohler of the United States Bureau of Animal Industry is perfecting a method of preventive vaccination. Unless the conditions are especially favorable for goat raising it would seem inadvisable to give up other lines of agriculture which are known to be profitable for this business. Under favorable conditions, however, where large areas of rough, high, dry land, covered with coarse herbage, are present, goat raising may yield larger profits than any other line of agriculture.

The weight of the fleece of goats varies according to the variety of the breed, and the market price varies likewise. In general, it is not considered desirable to raise crosses of low grades for mohair alone. Pure bred Angoras and crosses of fifteen-sixteenths pure blood are profitable animals for the production of mohair. From such goats 3 or 4 pounds of mohair is obtained, which brings from 30 to 40 cents per pound. A number of companies have recently been organized for the purpose of promoting the Angora goat industry in this country, and many experiments in crossing and feeding are in progress. It has been proposed to capture a few specimens of the wild goat of the Rocky Mountain region and attempt to make crosses between it and Angoras. The wild goat of the Rocky Mountains bears a fairly good weight of valuable mohair.

As would be expected from the great similarity of the digestive organs of goats to those of sheep, practically the same feeding materials, in the same ratio, may be used in feeding both of these animals.

Among the many breeders of Angora goats in this country mention may be made of C. P. Bailey & Sons Company of San Jose, California; William L. Black of Fort McKavett, Texas; J. R. Standley of Plattville, Iowa, and G. A. Hoerle of Ridgewood, New Jersey. For details of the goat industry consult Bulletin 27 of the Bureau of Animal Industry; "New Industry, or Raising the Angora Goat and Mohair for Profit," by W. L. Black, and a manual on "Angora Goat Raising," with a chapter on "Milch Goats," by G. F. Thompson.

VETERINARY MEDICINES

In administering drugs to domesticated animals the most convenient and practical methods for use of stockmen are by drenches, in the form of powder or solution upon grain feeds, or in hypodermic injections. The use of capsules is not so generally practiced among farmers, but drugs may be easily administered in this manner by veterinarians. Drenches may be given in several ways. Round-neck bottles, horns, rubber tubes connected with bottles, and special devices made for the purpose, may be used according to circumstances and convenience. All drugs which are somewhat irritant in their pure form should be mixed with meal or dissolved in a sufficient quantity of water to render them harmless.

Medicines are usually divided into a number of classes according to their action or physiological effect. A few only of these classes can be mentioned in this connection.

Antiseptics are substances which prevent or check the growth of bacteria which cause putrefaction or disease. The most common antiseptics are table salt, carbolic acid, corrosive sublimate, formalin, iodoform, zinc chlorid, iron chlorid, etc.

Disinfectants and deodorizers are used for similar purposes and also to absorb moisture and disagreeable odors which may have been developed. Permanganate of potash, sulphurous acid and chlorid of lime are examples of this class of drugs.

Vesicants are blistering agents. Common drugs of this class are cantharides or Spanish fly, croton oil, strong acids, silver nitrate, butter of antimony, etc.

Purgatives, also known as laxatives or cathartics, are drugs used for the purpose of producing a loose condition of the bowels. In veterinary medicine the drugs most used for this purpose are Glauber salts, Epsom salts, aloes, castor oil, jalap and croton oil.

Tonics is the name of a class of drugs which have a tendency to improve the appetite and increase the vigor of the animal. This name may also be used in a broad sense to include stimulants. The common drugs included under this class are quinine, sulphate of copper, sulphate of iron, other salts of iron and copper, ammonia, alcohol, ether, etc.

Alteratives are drugs which neutralize or counteract the formation of disease products or processes in the blood. The most frequently used alteratives are mercury, iodin, arsenic and various salts.

Narcotics constitute a class of drugs of which the effects are too well known to require description. In veterinary medicine opium, Indian hemp, belladonna and chloral hydrate are most frequently used for this purpose. The following brief notes may serve to indicate the doses and action of some of the more common drugs used in veterinary practice:

ACONITE lowers the temperature, weakens the pulse and causes sweating. Dose for horses 20 to 30 drops, for cattle 30 to 40 drops, for sheep 3 to 5 drops.

ALOES (Barbadoes) is a purgative and is generally administered to horses. Dose for a horse 4 drams, for a dog ½ dram.

AROMATIC AMMONIA is a stimulant and an antidote for acid poisons. Dose for a horse 1 to 2 ounces, for cattle 2 to 4 ounces, for sheep ½ to 1 dram. Locally it acts as a blister.

ARECA NUT is used as a vermifuge. Dose for horses, cattle and asses 1 ounce, for sheep 3 drams.

ARSENIC is an alterative and nerve tonic. Dose for horses 5 grains, for cattle 5 to 8 grains, for sheep 1 grain.

BISMUTH (Subnitrate) coats the walls of the stomach and intestines and soothes irritation. Dose for horses 2 drams, for sheep 20 grains, for dogs 5 to 10 grains.

BROMID OF POTASH lowers the temperature slightly and checks nervous excitement. Dose for horses 2 to 4 drams, for sheep ½ dram, for dogs 5 to 10 grains.

CALOMEL is a strong cathartic. Dose for horses 1 dram, for cattle 1 to 2 drams, for dogs 3 to 4 grains.

CANTHARIDES used locally is a strong blistering agent. Given internally it is a stimulant. Dose for horses 5 grains, for cattle 5 to 10 grains, for sheep 1 to 2 grains.

CARBOLIC ACID is chiefly used as an antiseptic and disinfectant. For ordinary purposes it should be used in a solution of water in the proportion of 1 part of carbolic acid to 100 parts of water.

CASTOR OIL is a mild purgative. Dose for horses 1 pint, for cattle 1 to 1½ pints, for sheep ¾ ounce, for dogs ½ ounce.

CATECHU is an astringent. Dose for horses 2 to 5 drams, for cattle 3 to 8 drams, for sheep 1 to 2 drams, for dogs 10 to 30 grains.

CHLORAL HYDRATE is a powerful narcotic and especially valuable in the treatment of spasmodic colic. Dose for horses 1 ounce, for sheep 2 to 3 drams, for dogs ½ dram.

CORROSIVE SUBLIMATE is a corrosive poison much used as an antiseptic. For ordinary purposes it should be used in a solution in the proportion of 1 part of corrosive sublimate to 1000 parts of water.

FORMALIN is a non-corrosive, non-poisonous antiseptic of great value, its chief disadvantage being its irritating effect on the eyes and nose. For ordinary antiseptic purposes, such as the treatment of wounds and disinfecting instruments or receptacles, it may be used in a 4 per cent solution in water.

GENTIAN is a bitter tonic. Dose for horses 4 drams, for cattle ½ to 1 ounce, for sheep ½ dram, for dogs 10 to 20 grains.

GINGER is used as a stimulant and stomachic. Dose for horses 1 ounce, for cattle 2 ounces, for sheep ½ ounce.

INDIAN HEMP is a narcotic and much used, like chloral hydrate, in spasmodic colic. Dose for horses ½ to 1 dram, for sheep 10 to 15 grains, for dogs 1 to 2 grains.

IODID OF POTASH is used as an alterative in the treatment of various infectious diseases, such as big jaw, for which it is a specific. Dose for horses ½ dram, for cattle 1 to 2 drams.

Jalap is a purgative most used for the smaller domesticated animals. Dose for hogs 1 to 2 drams, for dogs ½ to 1 dram.

Iron Peroxid, Sulphate or Carbonate are used as general tonics. Dose for horses 2 to 4 drams, for sheep ½ dram, for dogs 2 to 5 grains.

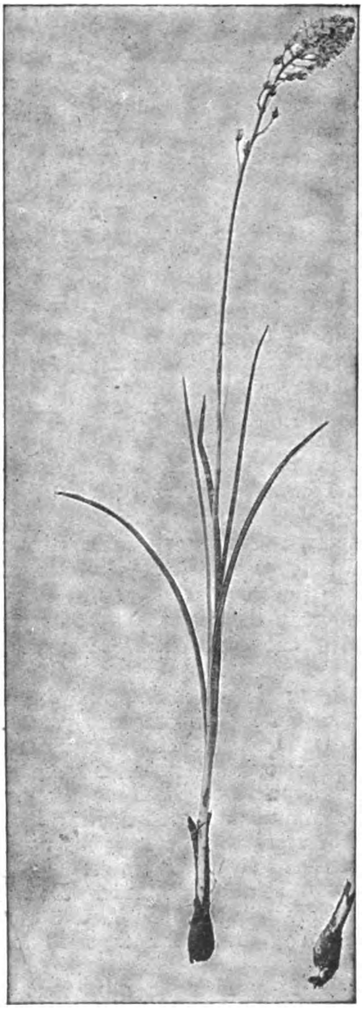


Fig. 411—death camas
(U. S. Dept. Agr.)

Lime Water is an astringent and antidote for acid poisoning. Dose for horses 4 to 5 ounces, for cattle 4 to 8 ounces, for sheep 1 ounce, for dogs 1 dram.

Linseed Oil is commonly used us a laxative. Dose for horses 1 to 2 pints, for cattle 1 to 2 quarts, for sheep ½ pint.

Olive Oil is used like linseed oil. Dose for horses 1 to 2 pints, for sheep 3 to 6 ounces, for dogs 1 to 3 ounces.

Opium is used as a narcotic for the prevention of spasms. Dose for horses ½ to 2 drams, for cattle 2 to 4 drams, for dogs ½ to 3 grains.

Quinine is a bitter tonic and most used in diseases accompanied with fever. Dose for horses 20 grains, for cattle 20 to 30 grains, for sheep 6 to 10 grains, for dogs 2 to 6 grains.

Sulphate of Soda or Glauber Salts is a purgative. Dose for horses 1 to 1½ pounds, for cattle 1 to 2 pounds, for sheep 2 to 6 ounces.

Sweet Spirits of Nitre acts as a stimulant, lowers the temperature and causes sweating. Dose for horses 1 to 2 ounces, for cattle 3 to 4 ounces, for sheep 3 to 6 drams.

Tincture of Iodin is frequently used in external applications to check local inflammation and as treatment for certain skin diseases. It may be painted on the affected parts with a brush.

Zinc Carbonate and Sulphate are used as astringents and tonics. Dose for horses 2 drams, for cattle 2 to 4 drams, for sheep ½ to 1 dram.

Use—For the use of the various medicines mentioned see under the diseases of *Cattle, Chickens, Dog, Horse, Swine, Sheep, Turkey,* etc.

POISONOUS PLANTS

A considerable number of wild plants have been shown to be poisonous in some degree to domestic animals and man. The most serious cases of stock poisoning from such plants naturally occur in the Western stock ranges, where for a greater portion of the year, stock are allowed to graze. Brief notes may be given on the more important plants which are concerned in stock poisoning.

Death Camas (*Zygadenus venenosus*) (Fig. 411) is a small, simple-stemmed perennial, with an onion-like bulb, narrow leaves and a cluster of yellowish-green flowers which blossom about the first of May. The plant is distributed from California to South Dakota, Nebraska and Utah. The symptoms are the irregularity in the movements of poisoned animals, accompanied by rapid breathing and spasms. In sheep, the pulse becomes rapid and the breathing is shallow. In the later stages there is a complete paralysis of the muscles. There is frequently observed a regurgitation of the stomach contents through the mouth and nostrils. See treatment at the end of this article.

Larkspurs are very generally distributed over the country and a number of species, especially in the Western States, have been suspected of being poisonous, by stockmen. Special attention has been given to purple larkspur (*Delphinium bicolor*) (Figs. 412 and 413) and tall larkspur (*D. glaucum*). The latter species is a simple-stemmed perennial, 4 to 7 feet high, with numerous flowers of pale blue color arranged in a long, slender terminal cluster. The plant blossoms in June and July. It is widely distributed from California to Alaska and east through the Rocky Mountains. The

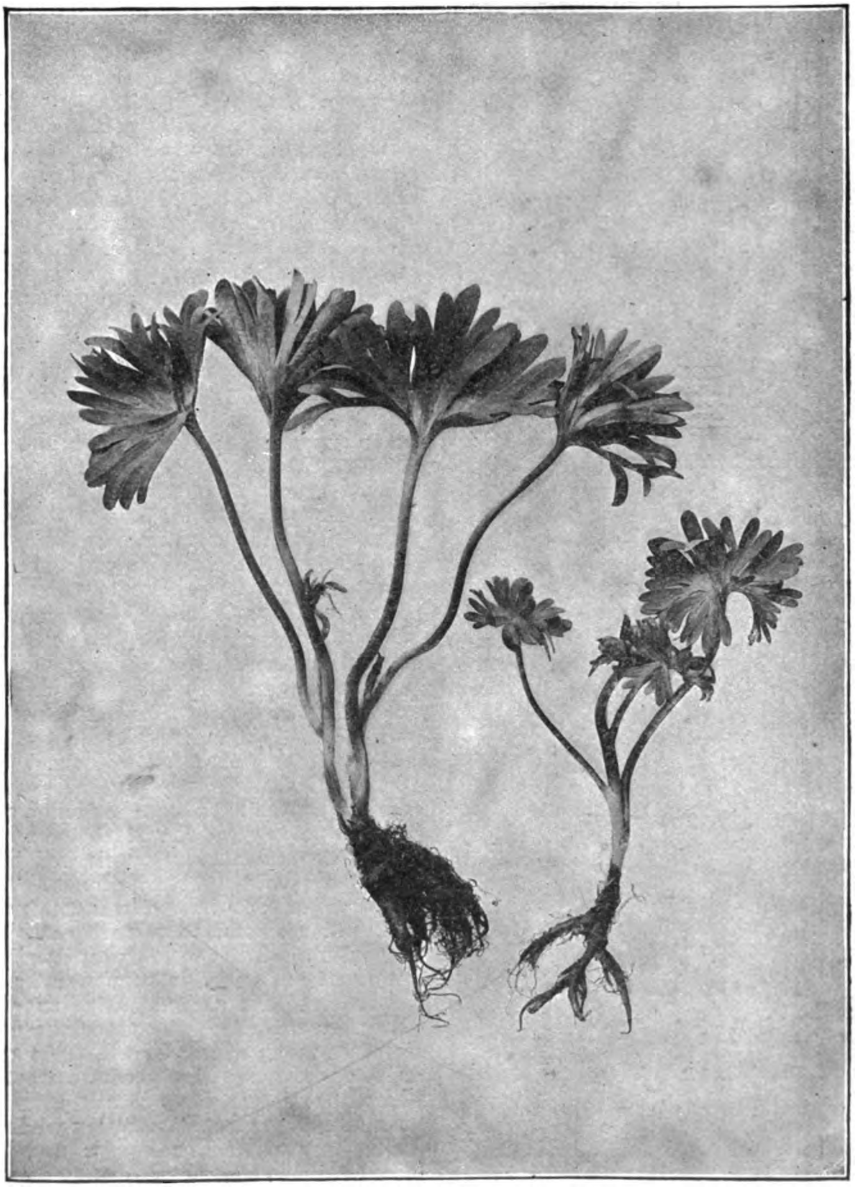


Fig. 412—PURPLE LARKSPUR, YOUNG PLANTS
(U. S. Dept. Agr.)

purple larkspur is a tuberous-rooted perennial, 1 to 2 feet high, with rich purple flowers which appear in May at ordinary altitudes. The plant is distributed from Colorado northwestward to Alaska. The symptoms of poisoning are very similar in both species and are easily distinguished from those of poisoning by death camas in the later stages. There is a stiffness and irregularity in gait at first and during the final stages in larkspur poisoning the animal manifests violent spasms interrupted by periods of quiet. The last stages of death camas poisoning are, on the other hand, passed in a sort of stupor. See treatment at the end of this article.

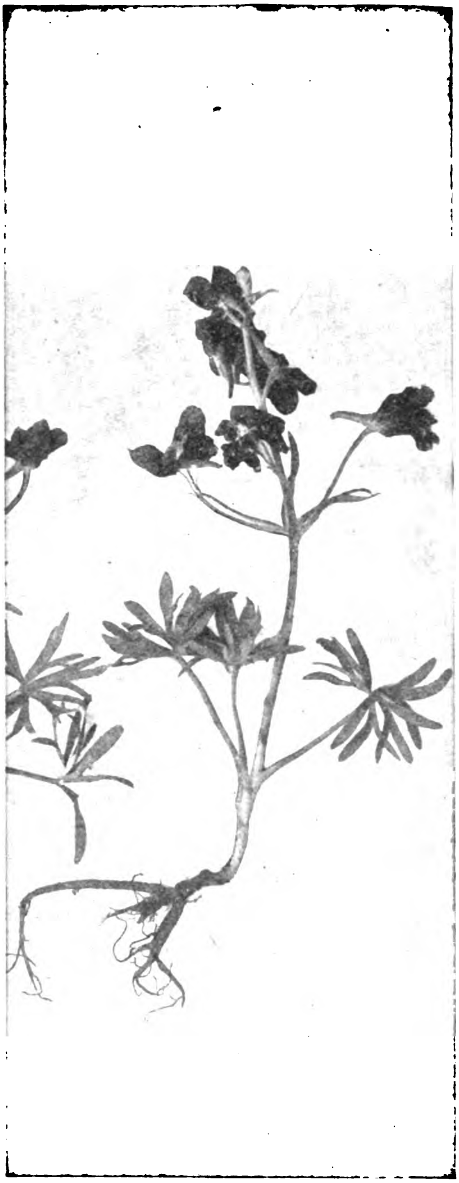


Fig. 413—PURPLE LARKSPUR, PLANT IN BLOOM
(U. S. Dept. Agr.)

Hemlock—Several species of water hemlock or poison hemlock are known to be exceedingly poisonous to animals and man. The most common species are: Oregon water hemlock (*Cicuta vagans*), Wyoming water hemlock (*C. occidentalis*) and Common water hemlock (*C. maculata*). (Fig. 414.) These plants are familiar to all stockmen and they are frequently known by the name of wild parsnip. They are smooth perennial plants with stems 2 to 6 feet high and compound leaves which rise from the ground and flat-topped clusters of white flowers. The symptoms of poisoning appear first as an evidence of severe pain and attempts on the part of the animals to run away. A sort of frenzy succeeds the first symptoms and the animals die in violent spasms sometimes within 15 minutes after the first appearance of poisoning symptoms. See treatment at the end of this article.

Loco is the name applied to a number of leguminous plants which occur on the Western ranges. The most common loco weed is *Astragalus mollissimus*, a perennial with an abundance of foliage in clusters from a short central stem. In other Northwestern States, several species of *Astragalus* are commonly known as loco weeds, of which the stemless white and various species of blue loco weeds should be mentioned. The symptoms of loco disease in animals are so familiar as not to require extended description. The most characteristic symptoms are of brain origin and consist in irregular actions which suggest a drunken condition. The special senses are often much affected, so that the animals do not see nor hear correctly. Locoed horses are likely to run away on the slightest provocation or even without seeing any particular object, and all locoed animals become ultimately emaciated and unable to care for themselves. In some cases death occurs within a few days, while in the majority of cases the disease runs a slow chronic course. See treatment at the end of this article.

Lupines, also called blue bean, blue pea, etc., are coarse, silky-haired, perennial herbs with blue or white pea-like flowers. The long-stemmed leaves have from 7 to 11 leaflets which rise from a common point. Lupines are much used as hay for sheep, cattle and horses and most animals eat the plant readily in this condition. Occasionally serious cases of poisoning occur from feeding lupine hay or from eating ripe lupines on the range. Apparently the plants are most poisonous when containing ripe or nearly ripe seeds and there is considerable evidence to show that they cease to be poisonous after the pods have ripened and the seeds have fallen out. (See also *Lupines.*) See treatment at the end of this article.

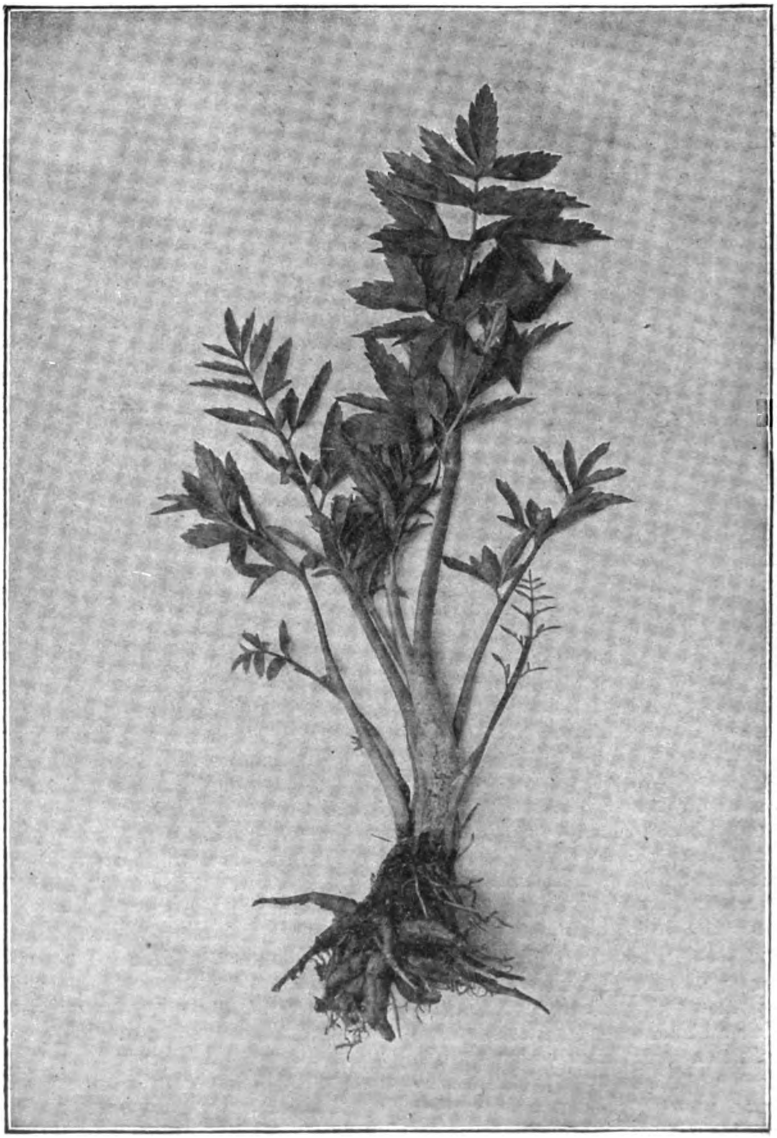


Fig. 414—WATER HEMLOCK
(U. S. Dept. Agr.)

Ergot is a parasitic fungus which infests a number of wild grasses, especially rye grass, bluejoint, as well as cultivated rye, and the form in which ergot is usually seen is that of black or brown spurs in the heads of infested grasses. These spurs are frequently mistaken by stockmen for the seed of grasses which could be distinguished by their large size and structure. The frequently observed effects of eating ergot are abortion and a sloughing of a ring of tissue around the leg near the crown of the hoof. This sloughing is due to the contraction of the blood vessels of these parts and consequent death of the tissue. Beside the more common effects of ergotism other effects are sometimes observed, such as a complete, slowly-progressing paralysis of the body beginning with the muscles of the throat.

Beside the species which have already been mentioned large numbers of others have been shown to be poisonous to a greater or less extent and a still larger group of plants have been suspected of being poisonous by stockmen or veterinarians. See treatment at the end of this article.

CORNSTALK DISEASE is an affection of cattle which appears especially after eating dried cornstalks in the fall. The nature of the disease is not well understood. It has been suspected that death was caused by an unusually high content of saltpeter or potassium nitrate in the stems. The exact cause of the trouble, however, remains undetermined. Complaints have been frequently made of serious or fatal cases of poisoning from eating smutted grass or smutty oats. Experiments with such material have usually been of unsatisfactory or contradictory nature and nothing definite may be said on the subject at present. Recent experiments in Nebraska indicate that no poisonous plant is eaten with the corn and that saltpeter is not always present in sufficient quantity to account for the poisoning.

Treatment—One of the most effective remedies for use in cases of plant poisoning is potassium permanganate combined with an acid salt, such as sulphate of aluminum. For adult sheep take from 5 to 10 grains of each of these substances and give as a drench in a pint or a quart of water. Horses may be given 20 grains of each, and cattle 30 to 50. Young animals should receive doses which are proportionately smaller. All of the mixture should be thoroughly dissolved before being administered, since potassium permanganate is a strong irritant. The effect of potassium permanganate is to destroy the plant poisons in the stomach before they have been absorbed and therefore before they have had any effect upon the animals. It is not a physiological antidote and does not antagonize the symptoms which are produced by plant poisons. It simply prevents any more of the poison from being absorbed into the blood. For combating the symptoms which have already appeared, various other drugs may be used according to the symptoms. In larkspur poisoning, hypodermic injections of atropin may be administered in doses of from ½ to 1 grain in horses and from 1-10 to 1-5 in sheep. In poisoning from water hemlock, morphine may be given hypodermically or chloral hydrate may be administered by way of the mouth. The dose of chloral hydrate for horses is 1 ounce or more, according to the violence of the symptoms. The same dose may be given to cattle, and sheep may receive about ¼ that amount. Morphine may be administered to sheep in doses of 1½ grains. In cattle and horses the dose may be from 3 to 10 grains. (Dept. of Agr., Div. of Botany, Bul. 26; Farmers' Bul. 86; Mont. Expt. Sta. Buls. 15 and 22; Bureau Animal Industry, Rpt. for 1900, pp. 91-121.)

CASTRATION AND SPAYING

Castration—This is an operation which the farmer is frequently called upon to perform. A few suggestions may therefore be given as to methods in castrating the stallion, bull, buck, boar and other male animals. Large animals may be held by throwing with rope or by the use of a chute.

The male calf, if not to be kept for a bull, should be castrated at the age of 2 to 3 months. An incision should be made through the scrotum so as to expose the testicles, which should be removed one at a time after cutting or preferably crushing off the spermatic cord by twisting, or by the use of clamps, ligature, or an ecraseur. In young animals there is little hemorrhage, but in old bulls the spermatic artery must be crushed off or held by a clamp in order to prevent bleeding.

Male colts should be castrated at about 1 year of age, or a little later if a larger build is desired. A cut should be made through each side of the scrotum parallel with the middle line. The testicle is then forced through the opening and the posterior half of the cord is cut off with a knife. This is the muscular part of the cord and severing it prevents the animal from exercising any further strain on the testicle. The testicle now hangs limp and the remainder of the cord may be cut off after applying clamps or by crushing with an ecraseur.

If boar pigs are castrated at the age of 1 to 2 months, or before they have seen any service, the operation may be safely done by exposing the testicle and cutting off the cord with 1 stroke of the knife. In old boars excessive bleeding may be prevented by crushing off the cord or applying clamps.

Lambs may be castrated at the age of 10 days to 2 weeks by cutting off the tip of the scrotum, pressing out the testicles and cutting them off with 1 stroke of the knife, or by biting them off with the teeth, as is the usual custom with Western sheep ranchers. No further precautions are necessary. Young goats may be castrated in the same manner.

Veterinary textbooks usually recommend that the scrotum and surrounding parts be carefully washed with some antiseptic solution and that the hands and instruments be similarly cleansed before the incision is made. The busy farmer seldom has time for these preliminary operations and bad results need not be feared when ordinary cleanliness is observed. It is well to have some powdered antiseptic such as iodoform in a tin box with perforated top. A little of the antiseptic may be quickly dusted into the scrotum immediately after the removal of the testicles.

In all animals the incision in the scrotum should be made lengthwise of the animal, parallel with and at a short distance from the middle line. The incision should be at the lowest point of the scrotum, and this corresponds to the point of greatest tension when the testicle is forced down by pressure with the hand.

The operator should be careful not to pull on the cord. Peritonitis and death may result from such strain, especially in colts. The cord should always be cut short enough so that it will not hang through the cut in the scrotum. If clamps or ligatures are applied to the cord, they should be removed after about 24 hours.

Spaying—The operation of spaying or removing the ovaries of female animals is practiced for several reasons. Mares are sometimes spayed for the purpose of preventing the disagreeable features of heat and the various tendencies often manifested at such times. Cows are occasionally spayed at the hight of the milking period in order to obtain a continuous flow of milk. Young cattle and pigs are often spayed to increase their fattening tendency.

When milch cows in full milk are spayed the period of milk flow is protracted for 1½ to 4 years. Some writers have maintained that the milk of spayed cows becomes richer in fat, casein and sugar. Careful experiments, however, show no changes in the milk after spaying. The animal gradually becomes fatter as the flow of milk diminishes. Spaying is of greatest importance in case of beef animals or heifers and cows which are not suitable for breeding purposes. When performed for this purpose, the operation is of considerable utility, especially on the Western stock ranges.

The following brief directions may serve to indicate how the operation is performed on cattle. The ovaries are small oval organs varying in size up to that of a walnut. They lie just at the end of the horns of the uterus and may be most conveniently found by following these structures with the hands. Cattle to be spayed may be roped and thrown or secured in a chute designed for holding animals in a fixed position. An opening may then be made in the right side, half way between the last rib and the prominence of the hip bone. The cut should be made with a knife with a guarded blade so as to avoid all danger of cutting the intestines. The hand is then inserted and as soon as an ovary is found the ligament connecting it with the abdominal cavity is cut with scissors or knife and the ovary removed through the cut in the body wall.

On the cattle ranges the operation is very quickly performed by cowboys, who receive about 50 cents per head for their work. Cowboys pay no attention to antiseptic conditions, but simply wash their arm and knife in a bucket of water and stitch the cut with a coarse cord like binding twine. Veterinarians often prefer to remove the ovaries through an opening in the wall of the vagina. In such operations the ovarian ligaments are crushed off by means of an ecraseur. Care should always be exercised to avoid mistaking a fold of the intestine, with its contents, for an ovary. In horses and dogs the operation should be done only by veterinarians, since there is much more danger attending spaying in these animals. Vicious mares are rendered more docile by spaying.

STERILITY IN ANIMALS

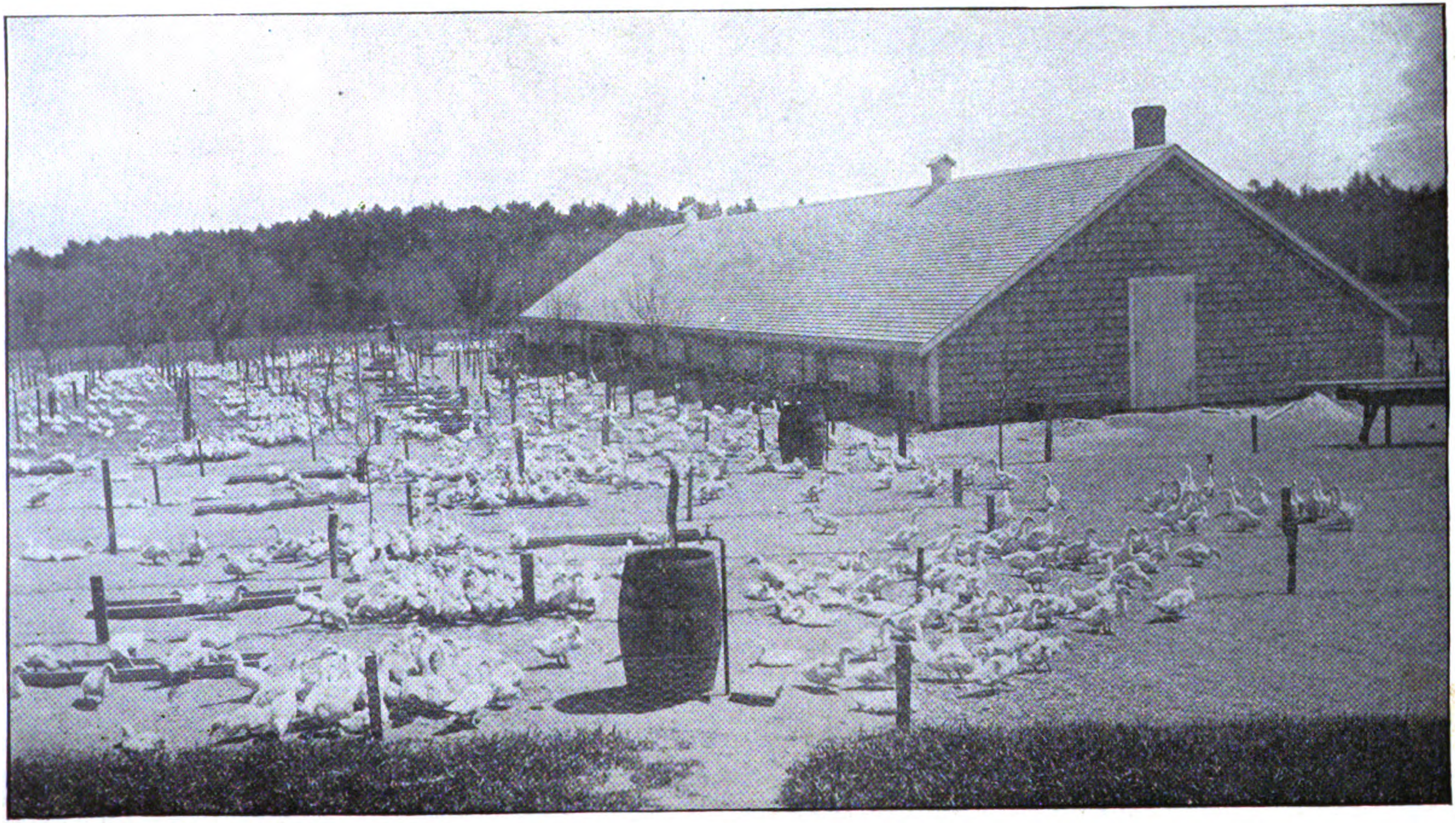
Sterility or barrenness in animals may be due to constitutional causes, to improper feeding, or to imperfections in the reproductive organs. Male animals may be permanently sterile from failure of the testicles to descend. The testicles are sometimes rendered non-functional from inflammation set up by blows or by contagious diseases. The penis may be malformed or may receive injuries so as to render the animal sterile.

From extensive statistics collected in England on various pure and cross breeds of sheep, it was found that on an average about 5 per cent were barren. Of this number about 2 per cent are constitutionally barren ewes. A higher percentage of barrenness is usually due to causes which may be prevented. Within certain limits barrenness does not depend on the age of the female animal. It has been observed, however, that there may be more barrenness when young rams are used.

In cows and horses, barrenness may reach as high as 20 or 30 per cent. Fatty degeneration of the ovaries or testicles is to be avoided by a more nitrogenous diet and by proper exercise. Breeding animals should be neither fat nor poor but should be kept in good vigorous condition. In mares and, more frequently, in cows, the neck of the uterus may become hardened and swollen so that the opening is closed and the semen excluded. If this condition is present, it can readily be determined by inserting the arm into the vagina. In the mare the uterus may be dilated with the finger. In cows this is usually more difficult or even impossible. Special instruments have been devised for this purpose but such operations should be done preferably by trained veterinarians, since the uterus is easily lacerated by careless handling. Syringes may be obtained from dealers in veterinary instruments by means of which semen may be taken from the vagina immediately after service and introduced directly into the uterus.

PART VI

POULTRY



A DUCK FARM ON LONG ISLAND, NEW YORK

FARMER'S CYCLOPEDIA OF AGRICULTURE

POULTRY

CHICKENS

Poultry raising on the farm is considered an incidental line of work and is frequently left to the care of the women of the household. The success of specialists in poultry raising is sufficient proof, however, that this industry may be made profitable when conducted on a large scale, under suitable conditions. Good profits may be obtained from raising chickens on a farm as a mere side line, provided a market is convenient, and even when no attempt is made to sell the products of poultry raising, the eggs and meat constitute an important item in the food of the family.

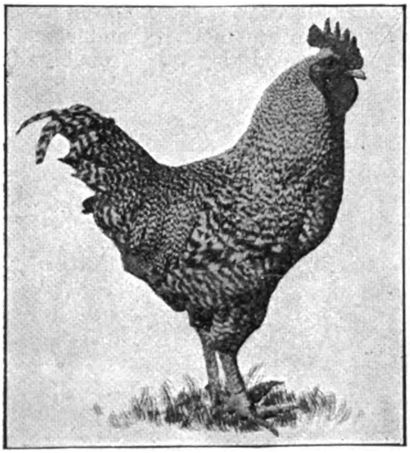


Fig. 416—BARRED PLYMOUTH ROCK COCKEREL
(From Utah Expt. Sta. Bul. 67)

Buildings and Yards—In order to raise chickens successfully some sort of buildings, yards and pens are required. The construction of these buildings will depend upon the circumstances surrounding each case, and particularly upon the amount of stress laid upon the industry in individual cases. Chicken houses should be moderately warm, well ventilated and abundantly lighted. The floors should be preferably of earth; earth floors may be more easily cleaned than wood floors and serve also as a convenient scratching ground for the fowls. The floors may be kept covered with clean, dry soil, or a litter of straw may be scattered in the house. The straw should be renewed at frequent intervals, and in so doing the droppings are also removed. If grain is fed in the house it should be scattered in the straw. The birds are thus induced to take a proper amount of exercise in scratching for the food. The roosting room and the scratching room should be separated, if possible. Dust baths should be provided of ordinary road dust, ashes, sand, gypsum, or other material, according to circumstances. Where poultry is raised on a large scale it is well to collect and store quantities of dry earth or other similar material for use in winter. Large poultry raisers sometimes prefer

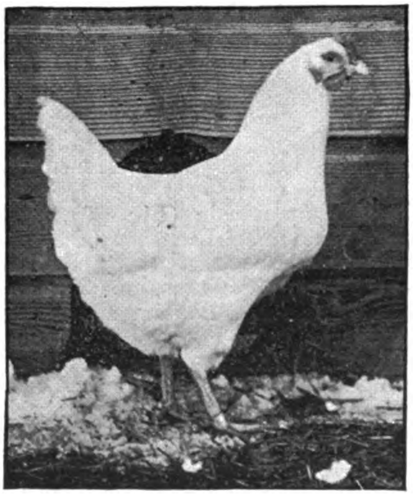


Fig. 417—ROSE-COMB WHITE WYANDOTTE PULLET
(Utah Expt. Sta.)

movable houses, in order to prevent the soil from becoming befouled and giving rise to diseases.

The outdoor inclosures for chickens will depend upon the special conditions in each case. It may be convenient to allow them to run in orchards or in gardens where small fruits are raised. This will insure the destruction of large numbers of insects and earthworms and also of diseased and fallen fruit.

Breeds—The breeds of the domestic hen may conveniently be classified into 4 groups: (1) GENERAL PURPOSE BREEDS, of which the most prominent are Plymouth Rocks (Fig. 416), Wyandottes (Fig. 417), Dorkings, Houdans (Fig. 418), and Rhode Island Reds (Fig. 419); (2) EGG BREEDS, in which class mention may be made of Leghorns (Figs. 420 and 421), Andalusians, Minorcas (Fig. 422), and Spanish breeds; (3) MEAT BREEDS, of which the Cochin (Fig. 423), Brahma (Fig. 424), and Langshan (Fig. 425) are perhaps the best representatives; and (4) FANCY BREEDS, of which the Polish Game and Bantam are perhaps best known.

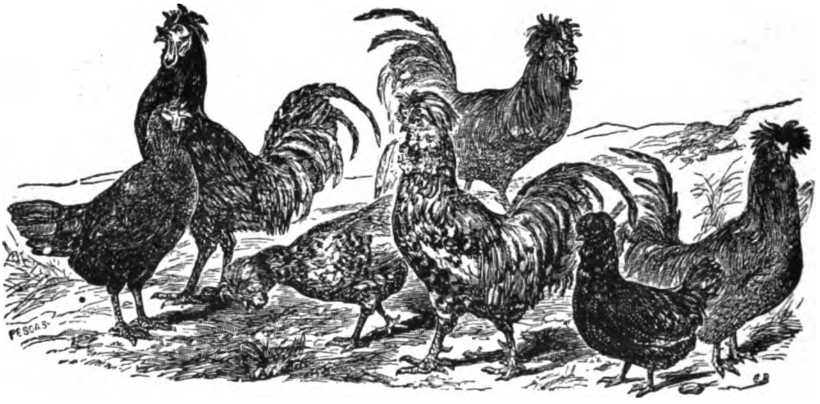


Fig. 418—HOUDANS AND CREVECOEURS

The EGG BREEDS are distinguished from other breeds of fowls by their small size, moderately long legs, neat, trim appearance, and active habits. These breeds, as a rule, show no tendency to take on an excessive amount of flesh. They require exercise and liberty in order to attain the best development and produce the best results in egg yield. The White Leghorns may perhaps be considered the best breed for laying, in winter and summer. Other Leghorns, especially the Brown, as well as the Andalusians, are noted for their laying propensities.

The MEAT BREEDS are characterized by their large size, slow movements, sluggish nature, short, feathered legs, and tendency to become fat. The largest fowl of this class is the Light Brahma, which is usually about 1 pound heavier in weight than the Dark Brahma. The Langshans are somewhat more active than either the Brahmas or Cochins, and for that reason are preferred by some poultry raisers. The Brahma and Cochin are good sitters and mothers, but they are so heavy and their movements so awkward that the eggs of lighter breeds may be broken or the chickens trampled to death after hatching.

The GENERAL PURPOSE BREEDS, as the name indicates, include to a certain extent the characteristics of both egg and meat breeds. These fowls are of medium size and activity and some of them are good layers. Probably the favorite breed in this class is Plymouth Rock. Plymouth Rock hens are considered the best breeds for sitting. The Wyandottes are of more recent origin than the Plymouth Rocks but are rapidly becoming popular and possess the good points of Plymouth Rocks in almost equal degree with that bird.

A characterization of the breeds of the domestic fowl would require too much space for present purposes. The selection of breeds by the individual farmer and poultry raiser will depend entirely upon the objects he has in view and upon his special conditions. After a good selection has been made, breeding should proceed upon the ordinary principles which are observed in the breeding of other stock. The best fowls should be selected for breeding, and left-overs which remain after the better fowls have been sold for market should never be used for this purpose. The most promising pullets and cockerels should be selected, at the age of 5 or 6 months. For hatching, the eggs of the most vigorous and active pullets should be chosen. In this connection it is well to remember that the constant presence of male birds is necessary in order to secure fertile eggs. It has been demonstrated that eggs laid 10 days after the removal of male birds are almost all sterile. It should also be stated that eggs do not become immediately fertile after introduction of males among the hens. Observations on this point indicate that within 10 days after the introduction of the males about 75 per cent of the eggs become fertile. In Canada, Shutt obtained gains in various breeds at the following costs per pound: Light Brahma-Plymouth Rock cross 3.7 cents, Plymouth Rock 3.8 cents, White Wyandotte 4.2 cents and Rhode Island Red 4.7 cents.

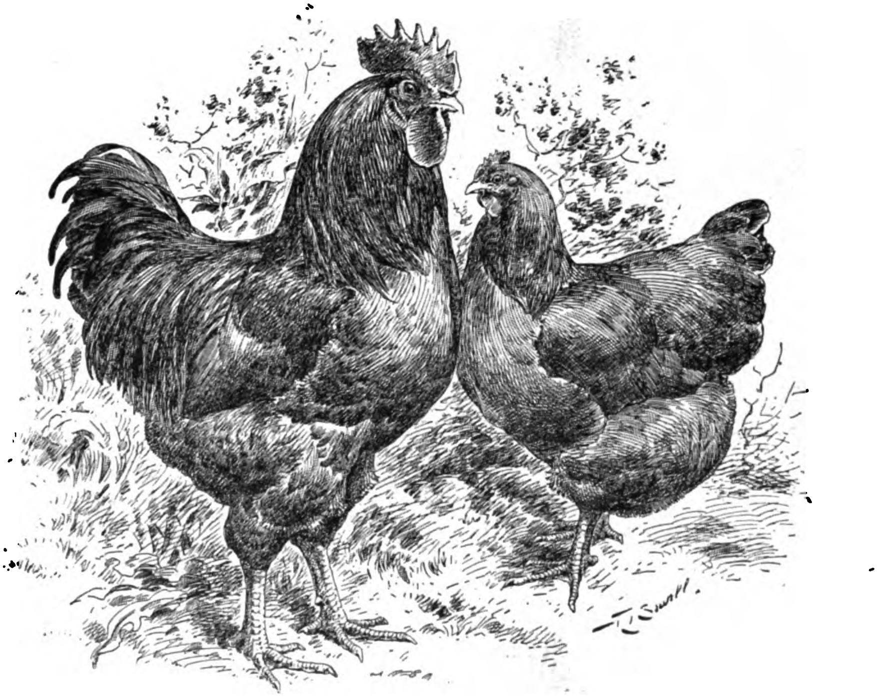


Fig. 419—PAIR OF RHODE ISLAND REDS

Management—Hens lay as many eggs when separated from the males as when confined with them in the same pens. Some experiments on this point have shown no influence on egg production from the presence of the males. At the New York Cornell Station, however, it was found possible to produce eggs at 30 per cent less cost when the hens were separated from the cock.

There are several bad habits which the domestic fowl may acquire. One of the most disagreeable of these is the practice of feather-eating. In general it may be assumed that this habit is an indication of improper feeding and it is ordinarily corrected by a change of diet. The habit spreads by imitation and it may be well to kill the first fowls which become addicted to it.

Many experiments have been made for the purpose of determining the amount of space which is required for fowls in houses, for most profitable egg and meat production. At the Maine Station it was found that on 160 square feet of floor space 20 hens produced more eggs than 30 hens in the same space. This result indicates the approximate limit of crowding under normal conditions. In West Virginia experiments with curtains for keeping hens warm at night were unfavorable to their use.

With regard to the subject of exercise, experiments are not strictly in harmony. In feeding for market it is not desirable to allow the fowls more exercise than is strictly required to keep them in a healthy condition. Where the experiments extend over considerable time, the lack of exercise will bring about an unhealthy condition, but where the birds can be prepared for market within 2 weeks, the matter of exercise is of minor importance. In laying hens exercise has been found beneficial for egg production. At the Utah Station, however, the results of observations on this point for 3 years were somewhat indecisive. In general it may be said that the healthful or unthrifty condition of the fowls will largely determine the question as to whether more or less exercise is needed. A great difference in the amount of exercise required is shown in different breeds of fowls. Recent experiments in various States are decidedly in favor of a liberal amount of exercise.

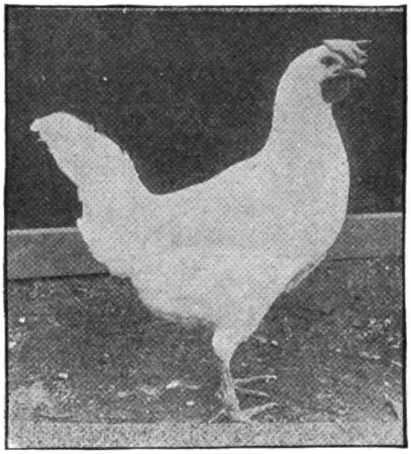


Fig. 420—WHITE LEGHORN PULLET
(Utah Expt. Sta.)

The age of fowls at which most profit is to be expected has been fairly well determined by experiments at experiment stations in the United States and Canada. At the West Virginia Station old hens laid more eggs than pullets, but gained much less in weight during the experiment. In Utah the profit in feeding pullets for egg production was found to be 6 times greater than in feeding hens. In North Dakota egg production was much greater in pullets than in old hens. Similar results were obtained at the Cornell Station. In these experiments pullets which were hatched in April were found to be more profitable than those which were hatched in May. Leghorn pullets averaged about 200 eggs per year. At the Cornell Station the average daily production per 100 hens was 23.2 eggs, the average yearly production per hen 129.7 eggs. At the same station the average cost per dozen eggs for the year was 9.2 cents, from December to March 16.3 cents. The average cost of feeding a hen for a year was 99.6 cents, while the annual profit on each hen was $1.31. In a period of 17 weeks 100 hens produced $23.93 in excess of the cost of feed. The amount of food consumed was found to be practically the same during the first, second and third years of age, but the egg production gradually declined during these years. The total food per day was 3 ounces for Leghorns, 3¾ ounces for Wyandottes and 4 ounces for Plymouth Rocks, not including the green food. In South Carolina the total cost for feed per chicken up to 8 weeks of age was 7½ cents.

The most favorable general conditions for successful poultry raising are moderate climate, dry weather and dry soil. These conditions are best realized in the southwestern portion of the country, especially in Texas, Indian Territory, Oklahoma, Kansas and Arkansas. In Texas almost ideal conditions are found for poultry raising. Locations may be found where soil and climate are dry, and where the annual variation in temperature is very slight. The warm climate makes it unnecessary to house the fowls for any great length of time, and the outlay for a poultry plant is correspondingly reduced. A dry soil and

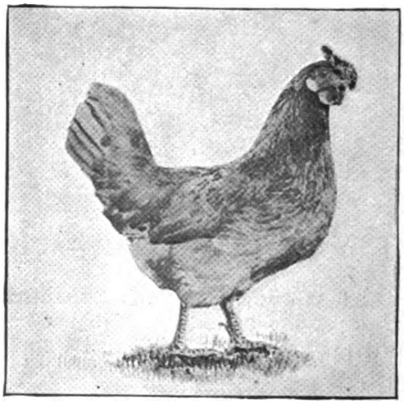


Fig. 421—ROSE-COMB BROWN LEGHORN PULLET
(Utah Expt. Sta.)

dry atmosphere prevent to a large extent the development of infectious diseases which are so severe in Northern, moist climates, and are also unfavorable to the excessive multiplication of lice and other insect pests of the poultry yards.

Securing Early Moulting—Moulting occurs earlier in pullets than in old hens. This matter is of considerable importance, since regular winter egg laying does not begin until after the fowls have recovered from moulting. The process appears to be helped along by a free run in the field, with meat and a green feed diet. Experiments at the Rhode Island Station on the effects of wide, medium and narrow rations (see *Feeding Farm Animals* for definition of these terms) upon moulting gave results which indicated no difference in these rations with regard to moulting. Extra care about the moulting period will be abundantly repaid by earlier and more prolific egg production. If the moulting process should appear to be delayed, a tonic containing ½ teaspoonful tincture of nux vomica in 2 quarts of drinking water may be administered.

Recently a method of hastening the moulting process, devised by Henry Van Dreser, has been tested and found to work admirably. According to Van Dreser's original plan the fowls are confined in their various apartments about August 1. They are allowed only ¼ of their usual rations for a period of 10 days. During this time they lose flesh and stop laying. They are then liberated and fed all the corn, oats, peas, sunflower seed and wheat that they will eat. This causes a rapid moult, and the new feathers start at once. The hens soon recover from the process and begin to lay regularly about October 1.

In explanation of the results obtained by this method it is suggested that as a result of reducing the ration growth ceases in all tissues, especially in the feather follicles. This causes a loosening and rapid shedding of the feathers. The heavy rations fed during the growth of the new feathers prevent any loss of weight from the heavy strain on the birds during this period.

Stewart tested this method in West Virginia and found that mature hens, when fed sparingly for 2 weeks and then given a highly nitrogenous ration, moulted more rapidly and uniformly and went into winter in better condition than similar fowls which were fed an egg producing ration without inter-

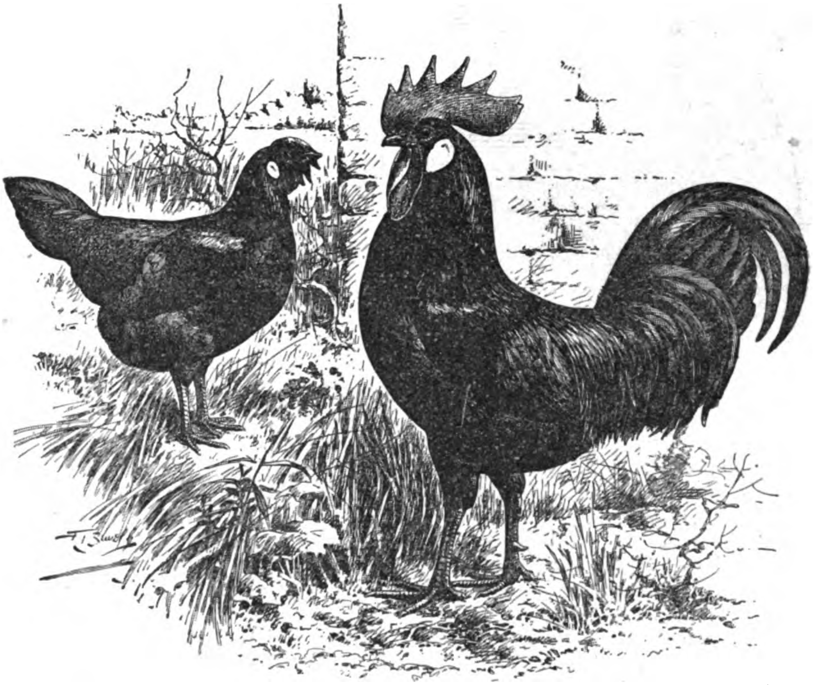


Fig. 422—PAIR OF BLACK MINORCAS

ruption. In Canada, Gilbert reduces the rations ½ during the first 2 or 3 weeks in July. At the end of July full rations are resumed with feeds of mash 3 times per week. The full rations consist of ground oats, shorts and corn meal. Hens thus treated are in good condition by the end of September and Gilbert hopes to reduce the moulting period still further. The importance of these experiments is apparent from the fact that the moulting period is one of non-production, and the more it is shortened the more the profits are increased, especially in the production of high priced winter eggs.

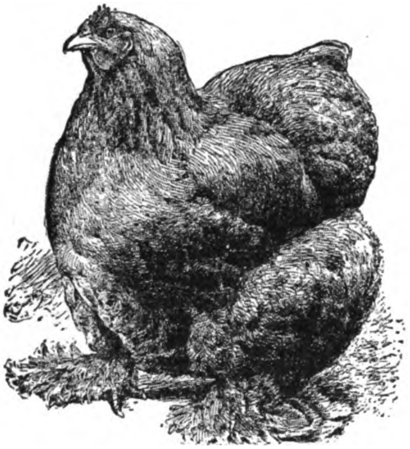


Fig. 423—COCHIN PULLET

Hatching and Brooding—Hatching on a small scale, where poultry raising is simply a side issue, is done best and most economically by means of hens. Where the industry is conducted on a large scale, however, hatching and rearing are usually accomplished by means of incubators and brooders. For this purpose joint stock companies and farmers have organized for hatching eggs in large numbers. With regard to incubators almost any make will prove satisfactory, provided one does not buy too cheap ones. If no experience has been had in the management of incubators, it is well to pay a visit where one is in operation and to study the matter. The temperature in the incubator should be 102° or 103° F. The natural temperature of the mother hen is about 103°. A temperature of 108° F. is fatal to the egg germs. Experiments have shown that eggs should not be allowed partially to cool off each day, as happens during incubation by the hen. The eggs should be turned at frequent intervals and arrangements should be made for thorough ventilation in the incubator and for the access of a proper amount of moisture. If moisture is not regularly supplied, the eggs should be sprinkled with warm water 2 or 3 times during the last week of incubation. This prevents the eggs from drying up by loss of moisture through the shell.

The eggs should be examined after 6 days' incubation in order to determine how many are fertile. Upon looking through the eggs placed at the end of a pasteboard tube toward the light, fertile eggs exhibit a dark, movable spot with several veins running from it, as seen in Fig. 426 at B; eggs with a weak germ show simply a cloudy spot surrounded by a ring-like structure and not provided with veins, as seen in Fig. 427; sterile eggs are clear and the yolk is readily seen. All except the perfectly fertile eggs should be removed and may be boiled as food for young chickens. In eggs with weak germs the chickens die from 6 to 20 days after the beginning of incubation. In general, eggs which will not hatch in the incubator cannot be hatched under hens, but under favorable circumstances hens are able to furnish better conditions for a successful hatching of eggs than can possibly be secured by artificial means. Eggs which do not hatch under a hen or in incubators are either unfertilized and sterile, or are furnished with a weak germ and therefore do not possess sufficient vitality to pass through a complete development.

A number of conditions are known to influence the fertility of eggs. It was found at the Louisiana Station that hens which are too closely confined in warm climates lay a large proportion of sterile eggs. The fertility of eggs is influenced by the number of hens to each cock. At the Montana Station it was found that each cock might be expected to fertilize about 200 eggs per month. The fertility of eggs may be influenced by the kind and amount of food. Hens which receive a forced feeding may become excessively fat and lay an undue proportion of sterile eggs. The first eggs obtained in the spring from hens which have laid throughout the winter are usually not fertile in a satisfactory proportion. In Canada, Gilbert received many complaints regarding sterility in early spring eggs. The sterility was attributed to improper diet, lack of exercise and close confinement. The germs became strong within 12 days after the hens were given an outside run. The influence of exercise of the hens upon the fertility of the eggs has not been determined in a satisfactory manner. In the majority of experiments exercise seemed to have a decidedly favorable influence upon fertility, while at the Utah Station exercise apparently reduced the fertility of the eggs. In general, the percentage of fertile eggs from pullets is higher than from old hens. Observations at the New York State Station showed that 50 per cent of Cochin eggs were fertile, and 76 per cent of Leghorn eggs. Experiments thus far made, however, do not permit general conclusions regarding the relative fertility of the eggs of different breeds. The fertility of eggs is best preserved by keeping them in the open air and at a temperature of 70° F. Tests in Queensland showed the need of moisture in incubators. Dry egg membranes take up oxygen too slowly. In recent experiments in Rhode Island 40 per cent of the eggs were hatched by incubators and 55 per cent by hens.

The period of incubation of hens' eggs is from 20 to 22 days, and is usually stated as being 3 weeks. In hatching eggs under hens it is necessary to give heed to moisture conditions. Experiments have shown that a smaller proportion of eggs hatched on dry boards than on moderately moist ground. Eggs under hens sitting in dry locations should be moistened once or twice with warm water during the last week of incubation.

If chickens are to be reared artificially there are 3 essential conditions which should be secured in brooders, viz.: warmth, ventilation and exercise. The temperature of the brooder inside of the flaps should be about 105° F., and the outside running ground of the young chickens should be protected against cold drafts or any excessive lowering of the temperature. If chicks become chilled soon after hatching they show a mass of dried feces about the anus and usually die within a few days. Abundant ventilation should be provided, since impure air combined with temperature changes may cause a large fatality from lung trouble in young chickens. An exerciser should also be furnished with brooders. According to numerous observations diarrhea and various other troubles in young chickens may be caused from lack of exercise. Shade is also essential to the growth of young chickens during the warm months, and water should be provided in most convenient manner according to circumstances.

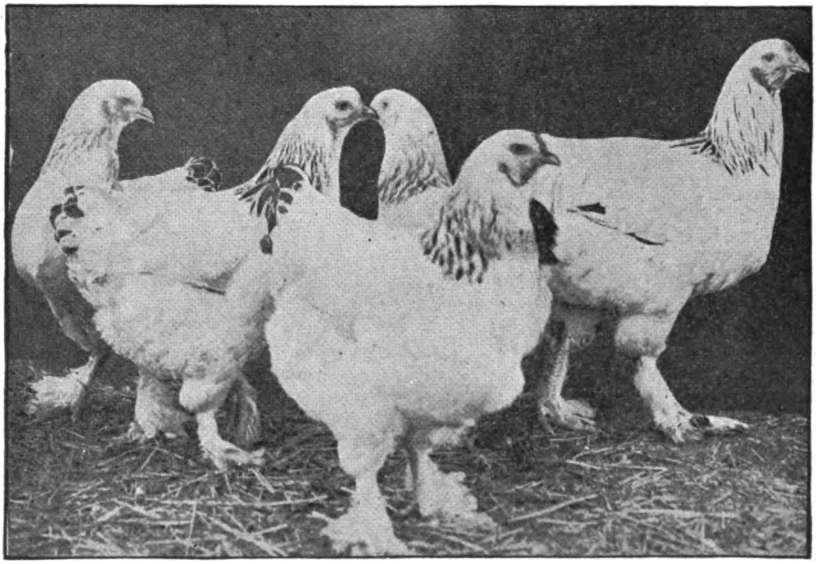


Fig. 424—PEN OF LIGHT BRAHMAS
(Utah Expt. Sta.)

Eggs; Preservation and Characteristics—Many methods of preserving eggs have been devised. The substances which have been used for this purpose include vaseline and other oily materials, wood ashes, gypsum, sulphur, sulphur fumes and sulphur, permanganate of potash, salicylic acid and salt brine, sodium silicate (water glass) in 10 per cent solution, dry table salt, lime water and salt brine (1 pound of lime and ½ pound of salt to 2 quarts of water). Of these methods the sodium silicate in from 3 to 10 per cent solution has generally proved most effective. Commercial water glass is sodium silicate, potassium silicate or a mixture of the two. Eggs can be successfully preserved for a year or more without developing a bad flavor. Dry table salt and lime water to which salt brine has been added are also effective but cannot be depended upon to preserve the eggs without change of flavor for so long a time. At the Toronto Station water glass and lime solutions gave the best results. In England these solutions and cold storage proved the best methods of preservation. Eggs should be treated as soon as cold. The months from March to June are perhaps best for preserving. The use of vaseline, wood ashes, gypsum and permanganate of potash is to be deprecated on account of the disagreeable flavor which they give to the eggs. It has been shown by experiment that unfertilized eggs keep better and longer than fertile eggs and they bring a better price in the summer for the reason that they possess a more agreeable flavor. The size of eggs varies greatly in different breeds of fowls. At the Utah Station it was found that first year eggs weighed considerably less than second year eggs. Large white eggs are laid by Black Minorcas, White Leghorns, Andalusians, Houdans, etc. Dark or brown eggs are laid by Light Brahmas, Langshans, Buff Cochins, etc. The average loss of weight of eggs during incubation is about 10 per cent. In Denmark it was found that in shipment large eggs broke more easily than small ones. Hens should be given plenty of lime for shell production.

Fig. 425—LANGSHAN COCK

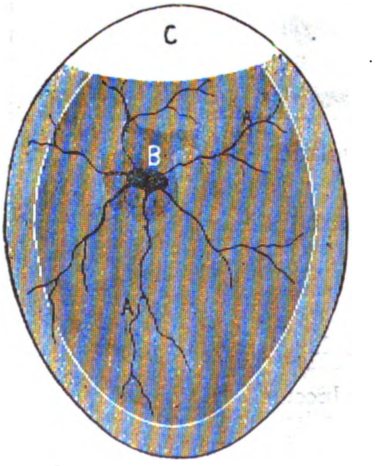


Fig. 426—FERTILE EGG

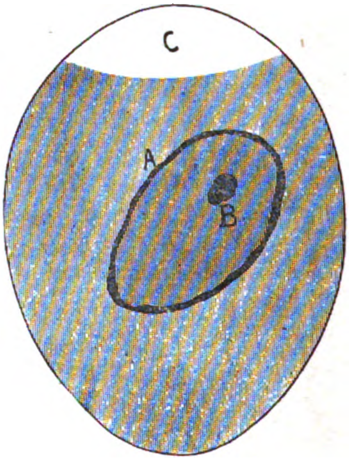


Fig. 427—STERILE EGG

Feeding Young Chicks—According to experiments at the Ottawa and Toronto Experiment Stations the feed for young chicks on the first day should be bread crumbs, either dry or soaked in milk and then squeezed nearly dry. On the second day granulated oatmeal may be added, and later crushed grain, whole wheat, meat and mash may be fed. For drink, whole or skimmilk is most suitable for young chickens. Young chickens should be fed often and but little at a time. The food should not be sour. Millet seed is excellent food for young chickens after they attain the age of 4 or 5 days. As a rule grain should not be fed previous to 12 or 14 days. Another system of feeding which is highly recommended and which gives excellent results in general use, consists in giving boiled eggs for the first 3 or 4 days and then substituting minced liver or meat with an addition of cooked grain and green food. As a rule the feed which is given will vary according to the material which the farmer or poultryman has in store. Wide variations in the ration are possible within the limits of safety. The general proposition, however, should be laid down that young chickens after attaining the age of 1 week, as well as old fowls, should receive daily some grain, green food and animal food.

In Feeding for Winter Eggs it has been found that pullets will endure forcing much better than old hens. In experiments at the Canadian Stations 2 rations per day gave better results than 3; one ration was fed early in the morning and the other in the afternoon, while grain was scattered in the straw in the interval between in order to induce scratching on the part of the hens and thus give them proper exercise. The grain used for this purpose may be oats, wheat, barley, buckwheat or corn. From experiments at the Canadian Stations it would appear that plentiful exercise is essential to best egg production. The Canadian Stations recommend a ration of wheat, oats, vegetables and mash, with cut bone replacing the mash on occasional days, for old hens. In Ontario cooked feed for the entire ration caused serious digestive disturbances and loss of weight. For pullets a ration of wheat, vegetables and a mash containing shorts, corn meal and potatoes is recommended. The mash should contain some kind of green feed, such as cabbage, roots, onions, clover or alfalfa hay. Clover hay should be steamed and finely cut before being mixed with the mash. Pure water and an abundance of shell making material should be within easy reach of laying hens.

In general, the ration for laying hens should not be too heavy but should be varied at frequent intervals. It may be determined by careful observation of the hens whether there is a falling off in egg production or in apparent health. At the Massachusetts Station corn gave better results in egg production than a wheat ration. The cost of the corn ration was less by from 4 to 16 cents per dozen eggs, more eggs were produced on the corn ration both summer and winter, and the birds moulted earlier. Animal meal, in one set of experiments, proved much better than cut bone for egg yield, and opposite results were obtained in another experiment.

Taking all experiments into consideration, it is certain that some form of animal food is essential to the best egg production, and this may be either minced fresh meat, ground bone or animal meal—preferably fresh meat and bones. At the West Virginia Station ground fresh meat and bones yielded better results in eggs than animal feed. In later experiments beef scraps proved superior to ground fresh meat, bone, or milk albumen. Cabbages, in one experiment, proved to be superior to clover in the production of eggs. Many experiments have been made to determine the relative value of narrow and wide rations in egg production. At the Cornell Station a narrow ration produced more eggs but of a smaller size and poorer quality than those obtained from an exclusively corn ration. At the West Virginia Station a narrow ration produced more, larger and more fertile eggs than a corn ration. At the New York State Station the product of eggs from hens fed on corn meal was from 28 to 57 per cent greater than from hens kept on a more nitrogenous ration. The hens on the corn meal ration became fatter than the others. It was found also that the eggs were produced at a smaller cost when 1-3 of the grain was ground and moistened than when all grain was fed dry. Recent experiments in West Virginia show that for light breeds 1-3 to ½ of the grain ration should be ground and moistened, while with heavy breeds the best results were had from scattering whole grain on the ground. In Canada mash feeds were found very valuable for fattening old or young stock and effective in hastening moulting. Mash may produce too much fat in laying hens. The cost of fattening on finely ground grain was less than on whole grain.

Experiments to determine the effect of condition powders on egg production indicated that when these materials were mixed with the regular ration fewer eggs were laid than otherwise.

Hens should not be kept for laying purposes past 2 years of age. Excessively fat hens frequently lay eggs of abnormal shape, with thin and soft shells. The influence of the cock on egg production was practically nil, at the Massachusetts Station. The eggs weighed slightly more when the male was with the flock than when he was removed. At the West Virginia Station 3 times as many sterile eggs were obtained from hens in close confinement as from hens given a reasonable amount of liberty. Warm houses are essential to a good yield of eggs. The cost of feeding laying hens at the Utah Station was found to be from 60 to 64 cents per year for each fowl, and the cost of producing eggs from 4 to 6 cents per dozen.

In Feeding for Market less attention is required to securing exercise, since the period of feeding is usually not long and fowls are killed when ready for market. At the West Virginia Station a narrow ration was found to be more profitable than a wide ration for growing chickens. Corn fed exclusively did not give satisfactory results at the Cornell Station, especially in the development of feathers. When an abundance of milk is fed, green food may be omitted for short periods. Experiments have shown that with young chickens differing only 6 weeks in age a gain in weight is more rapid and economical in younger than in older broods. In general, the cost of gain increases with the increase in age, and also with the increase in weight. In Ontario the following amounts of grain were required per pound of gain: first week 1.8 pounds, second week 4.8 pounds and third week 5.5 pounds. At the Canadian Stations and in Maine better gains were obtained when chickens were given some liberty than in those which were too closely confined. At the Ottawa Station, Gilbert found that birds in pens with runs made larger gains on less feed than fowls in fattening coops. The color of the meat, according to different experiments at the Ontario College, may be somewhat influenced by the kind of feed. A ration of ground oats and buckwheat moistened with skimmilk produced a creamy white meat, while a ration of yellow corn produced a deep yellow meat. Skimmilk also produced a white skin. At the Rhode Island Station the loss of weight in dressing was found to be less in capons, and of the different breeds was most in Light Brahmas. A cross between the Indian Game and Light Brahma furnished a meat which was pronounced of the finest flavor. In general, better results have been obtained in feeding for market with pure breeds and first crosses than with scrubs.

The Food of Fowls may be divided into 3 classes: (1) GRAIN AND SEEDS, including corn, wheat screenings, oats, buckwheat, rye, barley, wheat, brewers' grains, etc.; (2) GREEN PLANTS, including boiled potatoes and raw cabbage in winter, grass, clover and alfalfa hay in summer, as well as carrots, beets, turnips, onions, and other roots; (3) ANIMAL FOOD, including butchers' waste, such as lungs, meat scraps and heads, clams, fish, insects, etc. As already indicated, all birds should have some food of each of these classes every day.

Grain for Chickens: BUCKWHEAT is used almost exclusively by the French in fattening and for egg production. It is highly recommended by the Ontario College, and is always eaten with relish and produces rapid gains in weight. It may be fed either whole or as meal.

CORN may be considered the chief and most economical poultry food. When fed in too large quantities without proper variety in the diet it may cause the fowl to become excessively fat, and is, therefore, not suitable as an exclusive diet in egg production. It may be fed whole, cracked, or in the form of corn meal, in a mash. When hens have an opportunity to take exercise and to obtain insects and green food, corn may be used as the only grain food with excellent results in the production of both meat and eggs. Gluten meal proved superior to clover meal at the Canadian Stations.

OATS, especially if the hull is removed, may be considered an almost ideal grain food for poultry in so far as its chemical composition is concerned. The meat of fowls fed on oats, however, is apt to be light colored and is often not so acceptable as a yellow meat. Peanuts proved a valuable poultry food in tests made in New South Wales.

Wheat is by some considered preferable to corn, for the reason that it is not so apt to produce an excessively fat condition in the hands of amateur poultry raisers. In California shrunken wheat gave good returns. In general the best results are obtained when no single grain is fed exclusively. A variation of diet should occasionally be made, or the different grains may be mixed in a single feed.

Sunflower Seed at the Utah Station apparently had no effect on the egg yield, but an exceptionally glossy plumage was observed on birds which received some of this seed in their ration.

Peas, either cracked or whole, may be fed for both egg and meat production, but they should be used largely as a variation upon the regular grain diet.

Cowpeas are readily digested by young poultry and constitute a nourishing and stimulating food. Experiments have shown that only slight benefits are to be derived from grinding them before feeding.

Kafir Corn—At the Oklahoma Station Kafir corn was found to be better digested when fed whole than when given as meal. Kafir corn proved to be a better ration for the production of growth or fat than Kafir corn meal, Indian corn or corn meal.

Green Feed for Chickens—Observations at the California Station showed Jersey Kale to be an excellent green food for all kinds of poultry. The birds may be allowed to feed upon it in the fall or it may be cut and fed to them in confinement. Carrots, turnips, mangels, onions and other roots may be fed either raw or cooked, and alone, or preferably mixed in mashes or with other kinds of food. In this way unmarketable vegetables may be put to a profitable use. Clover Hay, especially white clover, is highly recommended as being rich in nitrogen and lime and as keeping fowls in good health. When fed in connection with wheat or other grains good growth and egg production are secured. Cabbage and various other green feeds and roots are fed with good results in everyday practice but their feeding value for chickens has not been determined.

Animal Feeds for Chckens—In numerous experiments it has been found that the addition of Animal Food to the ration gives far better results than can be obtained on a diet containing only grain and green food. Skimmilk in experiments at the Indiana Station was found to be a valuable food for young chickens. It caused large and rapid gains and the profits were much increased by its use. It may be added to an otherwise well-balanced ration, or may be given along with green food, and is especially valuable when fed to chickens in confinement. In Ontario grain mixtures moistened with skimmilk were much more effective than when wet with water. Skimmilk as a drink proved far superior to water in experiments at Ottawa. Experiments show that it can be safely given in unlimited quantities. In fact, cows' milk may be considered an excellent poultry food in any form, either sweet, sour, skimmed or as buttermilk. It is equally good for egg production and for the growth of young chickens. Tallow added to a grain ration gives poorer results than linseed meal; the latter usually has the effect of hastening the process of moulting and is frequently added to the ration for this purpose. Dried Blood was found to have a high feeding value in the ration, for the production of eggs, in experiments at the Utah Station. Salt apparently has a beneficial effect when given in small quantities. It should not be fed in greater quantities than 1 ounce for 100 fowls per day. When fed excessively it may cause diarrhea and other digestive disturbances.

Proprietary Poultry Foods analyzed at the Connecticut Station were found to be much alike in composition, containing meat and bone. These foods are sold at enormous prices as compared with their nutritive value. Various condimental foods have been recommended for poultry, but they usually contain pepper, sulphur, iron, salts and other familiar substances which are kept in store on all farms and are to be bought for much less than must be paid for them in the proprietary combination.

Caponizing—The practice of caponizing has long been adopted on a large scale in European countries, but is of comparatively restricted development in the United States. The increased value of the meat of capons is sufficient to recommend the practice where a market for this class of fowls has been developed. The operation of caponizing, despite the frequent statements that it is simple and capable of being performed by anyone, should not be undertaken without previous practice on dead fowls. As a rule it is to be recommended that an expert be employed to do the operation upon a large number of fowls at the same time. The expense will thus be very trifling and the operation will be far more successful than if performed by an inexperienced person. The operation is performed by fastening the bird upon its left side, pulling back the wings, making an incision between the first and second ribs, as shown in Fig. 428, and removing the testes by means of an ecraseur. Occasionally the reproductive organs are not completely removed, and the bird then becomes what is known as a slip. Slips behave like capons for a few months and then develop the characteristics of roosters. A set of caponizing instruments can usually be bought for about $2.50 or $3. Complete directions for their use come with them and need not be repeated here.

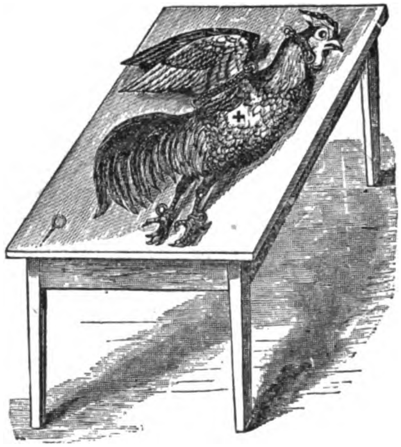


Fig. 428—CAPONIZING TABLE

Caponizing should be done as soon as the sex is recognized. Heavy breeds of birds, such as Brahmas and Plymouth Rocks, make the best capons. They should be killed for market at from 11 to 14 months of age. The labor of feeding capons is less than in the case of young chicks. The food may be the same as for other fowls. Skimmilk, if fed in large quantities, should be sweet. In experiments with wide and narrow rations no difference could be observed in meat production in capons. At the New York Station it was found that capons ate more when the ration consisted of ground corn than when whole corn was fed, and made more profitable gains on the former than on the latter. As is well known, the meat of capons is of superior quality. It brings from 4 to 6 cents per pound more than that of other fowls. Capons grow faster, become larger within a given time, and give more economic returns for food than other fowls.

At the South Carolina Station capons were found to be excellent brooders and nurses for young chicks, their long feathers enabling them to cover more chickens than a hen of the same size, and it was considered that they took better care of the chickens than did hens.

Marketing Chickens—Chickens are shipped to market both alive and dressed. In summer dressed chickens must be iced. Hence more are shipped alive in summer than in winter. Different markets have preferences as to methods of handling, and before chickens are shipped the commission merchant should be consulted as to how he prefers to handle them. About the only precautions to take in shipping chickens are to feed them well before crating, not to crowd too many in the crate, and to make the chickens in each crate as nearly uniform in color and size as possible. Commission merchants will supply crates free of cost upon request, the shipper paying only transportation charges. Tie some green food, preferably a half head of cabbage, in each end of the crate for the chickens to pick on the way. When the shipment is long some grain must be provided also.

Dressed chickens are usually shipped in barrels or boxes. No food whatever, except water, should be given them for 24 hours before killing. Dressed chickens are shipped with the head and feet left on and the entrails are not removed. Chickens are usually killed by running a sharp knife through the roof of the mouth to the brain so that they bleed freely. They are then hung up by the feet for all the blood to escape. The legs are first picked dry. The chicken is then held by the legs and head and dipped 3 times in water just below the boiling point. The head should not be dipped, as it discolors the comb and shrinks the eyes and gives the head a sickly appearance. The chicken should then be hung up by the legs so that both hands may be free to remove the feathers and pinfeathers, after which they should be "plumped." This is done by immersing them for an instant into water almost boiling and then into cold water. After "plumping" the chickens should be hung up by the legs and left until perfectly cold before packing.

Some markets prefer dry picked chickens. In dry picking the feathers must be removed immediately after the chicken is killed and before the body becomes cold. Greater care is required not to tear the skin. In packing chickens the head may be tucked under the wing but the body and legs should be straightened out. Pack snugly in the barrel or box to avoid sliding about in transit. It is advisable to market all old and heavy cocks before January 1, as after that date the demand is mostly for the smaller, round, fat fowls.

In shipping dressed chickens in summer a layer of finely cracked ice should be put in the bottom of the barrel, then a layer of chickens, alternating with layers of ice until the barrel is full. A layer of cracked ice should cover the top layer of chickens. This should be covered over with a piece of burlap, then a large piece of ice put on and the whole covered over with burlap secured under the top hoop. Holes should not be bored in the bottom of the barrel, as it is better that the barrel hold water. Mark shipping directions plainly on the outside of the package and state what the package contains.

Diseases—For an account of the medicines and of the doses mentioned under the different diseases below see *Veterinary Medicines.*

ROUP is a contagious disease which affects the mucous lining of the mouth, larynx, nose and eyes. The infection often extends into the lungs and intestines. The disease is to be recognized by a yellow, thick mass or false membrane on the mucous lining of diseased parts. This false membrane is attached to the underlying tissues so that a bleeding surface is left when it is removed. The eyes are often covered over by such membranes and when the larynx is attacked the opening may be closed, so that the chickens die of strangulation. The first symptoms are a thin watery discharge from the eyes and nose, and general debility. A slight rise in temperature is noted and after 3 or 4 days the false membranes become conspicuous in the mouth. The disease is contagious and may be transmitted by healthy fowls eating pieces of the membrane which have been thrown upon the ground by diseased fowls. The disease closely resembles diphtheria of man and is caused by a bacillus which is similar to that of fowl cholera. Roup may also be transmitted by the virus coming in contact with the eyes of healthy fowls.

In treating the disease it is important that all affected fowls should be at once separated from the healthy fowls and should be placed in comfortable quarters with plenty of feed. The false membranes may be scraped from the throat and nostrils and the raw surfaces treated with carbolic acid, 1 part in 200 parts of water, peroxid of hydrogen in a 3 per cent solution with water, corrosive sublimate, or with a solution of nitrate of silver in the proportion of 8 grains to 1 ounce of water. The surfaces from which the false membranes are removed may also be rubbed with a stick of lunar caustic and the mouth cavity may be washed out with a nitrate of silver solution, as just mentioned. Attempts to inoculate chickens with diphtheria of man have proved unsuccessful, and it is therefore probable that the 2 diseases are distinct and not transmissible from man to chickens or from chickens to man.

FOWL CHOLERA is a contagious disease due to the action of a specific bacillus. Diseased birds become rapidly emaciated and exhibit a constant and profuse diarrhea. Medicinal treatment of the disease is not successful. Fowl cholera may be prevented from spreading through the whole flock by proper hygienic precaution. All chickens dead of the disease should be buried or burned at once, and all affected birds should be removed to some distance from healthy fowls. After an outbreak of the disease the poultry house must be thoroughly treated with a disinfectant, such as a 2 per cent solution of chlorid of lime. A mixture containing subnitrate of bismuth 3 grains, bicarbonate of soda 1 grain and powdered cinchona bark 2 grains, administered 3 times daily, is effective in checking the diarrhea. Under ordinary circumstances, however, it is better to isolate all diseased birds at once before attempting any remedial treatment, since in that way the disease would have less opportunity to spread among the healthy birds.

TUBERCULOSIS in poultry has been studied by the Bureau of Animal Industry and by the Oregon, Delaware and Michigan Stations. The disease has been supposed to be somewhat rare in chickens. Recently Moore investigated this disease in California, where it was found to cause the death of from 5 to 20 per cent of the fowls in certain flocks. Paleness of the comb, weakness and high temperature were the chief symptoms. The liver is affected in nearly all cases and shows numerous gray tubercles. For a general discussion of tuberculosis see under *Cattle*.

ASTHENIA OR GOING LIGHT is the name of a chicken disease first investigated by Dawson, then in the United States Bureau of Animal Industry. The chief symptom is extreme emaciation. There is no diarrhea and the appetite remains voracious. The disease is infectious and is due to a bacterial organism which is found chiefly in the small intestines. The course of the disease is usually somewhat prolonged. The percentage of mortality is high. Asthenia has been reported from Maryland and Delaware. In controlling an outbreak of this disease, affected birds should be isolated and given a purgative (castor oil in 2-teaspoonful doses or calomel in ¼-grain doses) followed by a stimulating tonic.

CHICKENPOX, also called sore head, is most prevalent in warm climates such as those of the Southern States, Hawaii, etc. The disease is due to a parasitic fungus which attacks the chicken usually on some part of the head. The first symptom is the appearance of a small eruption near the eye, ear or on the bill. Later other eruptions appear and spread until the eyes are covered and the fowls unable to find their feed. As soon as a diseased chicken is noticed it should be removed and the premises should be disinfected with whitewash, Bordeaux mixture or carbolic acid. The scabs may be removed from affected parts of diseased birds by washing in warm water or soapsuds, after which the raw surfaces may be painted with tincture of iodine, or washed with a solution of potassium permanganate (1 dram in 5 ounces of water) or with silver nitrate (8 grains to 1 ounce of water). Such treatment, together with a nutritious diet and tonics, usually brings about recovery.

GAPES is due to the presence of a threadworm (*Syngamus trachealis*) in the windpipe. Poultry attacked with this disease have fits of coughing, walk and stand in a drooping posture, and lose weight rapidly. It is believed by many authors that the gapeworms live during one of their stages in earthworms, and that, therefore, poultry may become infested by eating earthworms. Some experiments conducted for the purpose of obtaining evidence on this point indicated quite clearly a connection between the disease and eating earthworms. Chickens allowed to run upon the ground and eat earthworms ultimately became affected with gapes, while no case of gapes developed in those which were kept on a plank floor or in wooden cages with wire gauze sides. Experiments in feeding chickens earthworms produced evidence that the gapes may be acquired in this way. On the basis of this belief, it has been recommended that when chickens are allowed to run outdoors the soil should be previously saturated with a strong solution of salt for the purpose of destroying the earthworms. For the removal of the gapeworms in the windpipe several remedies are effective. Turpentine may be applied inside by means of a feather. Internal doses of asafetida, turpentine or garlic also have a beneficial effect. The fowls may be inclosed in boxes and made to breathe the dust of air-slaked lime. The violent coughing which is thus set up is sometimes sufficient to cause the expulsion of the worms.

MORTALITY IN INCUBATOR CHICKS depends upon a number of conditions and diseases which prevail under these conditions. In general the death of incubator chicks may be due to mechanical causes, such as overcrowding in the brooders and death by suffocation and trampling, imperfect sanitation, including bad ventilation and lack of sunlight, heredity or environment during the period of incubation, and improper feeding. In some instances, where little attention is given to the sanitary conditions of the incubator and brooder, death from tuberculosis occurs in about 15 per cent of the chickens. Tuberculosis in such cases is not inherited, but is developed as a result of infected brooders. A constitutional weakness, consisting of a failure to absorb the yolk at the usual rate, is frequently noticed.

In investigations conducted at the Rhode Island Station, 75 per cent of incubator chickens were found to be affected with a trouble in the gall bladder which led to the accumulation of a large quantity of gall. A green stain could be observed on the outside of the abdomen close to the posterior edge of the breast bone. This trouble is usually due to an improperly balanced ration, and indicates a lack of animal proteid substance in the diet. Liver, flesh, fish or refuse meat chopped up fine are recommended in such cases. In order to prevent digestive disturbances of a serious nature in incubator chickens, the diet should not only contain a sufficient quantity of animal food, but feeding should be a continuous process, so as not to allow the chickens to eat large quantities at times and then fast for long intervals.

LEUKAEMIA is an infectious and destructive disease which sometimes appears in an epidemic form. The course of the disease is short and death usually results in 2 or 3 days. It is almost invariably fatal. The symptoms of leukaemia are not well marked. Sick birds stand in a crouching position and show a roughened plumage. There is a marked rise of temperature, accompanied with a paleness of the comb. No diarrhea is to be observed in this disease. The changes in the internal organs are not striking and are usually in the upper part of the small intestines, which will be found to be reddened and covered with a secretion containing pus. In this material the bacteria are found which are the immediate cause of the disease. The bacteria are found in the feces, and the disease is probably transmitted through this material. The appetite remains good or is often voracious during the progress of the disease. The hygienic measures suitable for this disease are the same as recommended in the case of other diseases of poultry. A good tonic for diseased fowls is found in sulphate of iron, which may be powdered and given with the feed so that each bird receives from 2 to 4 grains daily.

INTERNAL CHICKEN MITE (*Cytodites nudus*) is white in color and barely visible to the naked eye. The mite is found in the lungs, air sacs, windpipe and in the body cavity of the common fowl and other domestic birds. It occurs in a number of widely separated localities, and may be considered of rather frequent occurrence. According to some authors the presence of the mites may cause a cough and strangulation of the birds, accompanied in some instances with diarrhea. The mites have been found, however, in healthy fowls, and it must therefore remain doubtful whether the mites are the cause of serious disease. The mites probably gain entrance to the body in the food.

SCALY LEGS is caused by a mite known as *Sarcoptes mutans,* which burrows underneath the skin of the legs and sets up an irritation which leads to an exudation of fluid, which becomes gummy on drying. The mites remain under these crusts. Affected birds should be removed from the rest of the flock, and the roosts and woodwork of their quarters should be treated with boiling water or whitewash to which a little carbolic acid has been added. The scales should be removed and exposed surfaces treated with an ointment made of balsam of Peru 1 to 2 drams, to an ounce of vaseline, or with some such ointment.

Another form of the disease known as depluming scabies attacks the feathers, causing them to break off near the skin. The disease begins at the rump and spreads from there to all parts of the body. It is due to a mite closely related to that which causes scaly legs. Affected birds should be isolated, and the diseased areas may be rubbed with the carbolized ointment recommended for scaly legs, or with cloves.

FAVUS, also known as white-comb or baldness, is due to the same fungus which causes one form of ringworm in mammals. The disease appears first upon the comb and neck as yellowish raised areas of circular or irregular outline. As the disease progresses the skin becomes covered with a crust sometimes ¼ inch in thickness. The feathers fall off from affected areas, leaving the skin bare. Favus is contagious and should be treated accordingly. Affected areas may be washed with warm water, so as to render the removal of the crust easy, and the parts may then be treated with an ointment composed of 1 part benzine, 20 parts soft soap, and a sufficient amount of sulphur to make the mixture of the consistency of paste.

LICE MITES AND TICKS—Chickens are attacked by a considerable number of parasitic insects and mites. Two of the mites have already been mentioned. Among the species which are most common on chickens, mention should be made of the chicken flea, chicken tick and various species of chicken lice.

These pests when present in great numbers constitute a serious drain upon the energy of the birds and cause considerable irritation of the skin.

DISINFECTION—Henhouses which have become infested with lice, mites or ticks sometimes resist all attempts at disinfection, and if the structures are not especially valuable, it may be well to burn them and build a new structure on fresh uninfested ground. Where such method is not practicable, the walls may be sprayed with kerosene or treated with whitewash to which carbolic acid has been added in the proportion of 4 ounces to 1 gallon of whitewash, or if the houses are air-tight, they may be thoroughly fumigated with sulphur. Pyrethrum powder or other suitable dust insecticide may be applied to the bodies of infested poultry. Recent experiments in Iowa show that repeated spraying with kerosene is effective against these pests.

For further details on poultry in general and chickens consult "The Book of Poultry," by L. Wright, "The New Egg Farm," by H. H. Stoddard, "Farm Poultry," by G. C. Watson, "Poultry Culture," by I. K. Felch, "Poultry Architecture," by G. B. Fiske, "Diseases of Poultry," by D. E. Salmon, and Pa. Dept. Agr. Bul. 17.

DUCKS

Ducks, like chickens, may be raised on a large scale in confinement. As a result of this, a large percentage of duck raising at present is conducted by specialists who have prepared extensive plants for the purpose. As a rule the ducks which are raised on farms are too few in number to affect appreciably the market price. Good returns, however, may always be obtained by farmers for young ducks in good market condition. Like geese and turkeys, they are seldom raised for their eggs, although the latter have an agreeable flavor. Duck eggs are produced at too great an expense to make duck raising profitable for this purpose alone.

The common breeds of ducks are probably descended from the wild Mallard duck, which is native to Europe and America. Of the various domesticated breeds, the Rouen most resembles the wild Mallard. The Mallard itself has frequently been domesticated, but usually without profitable results.

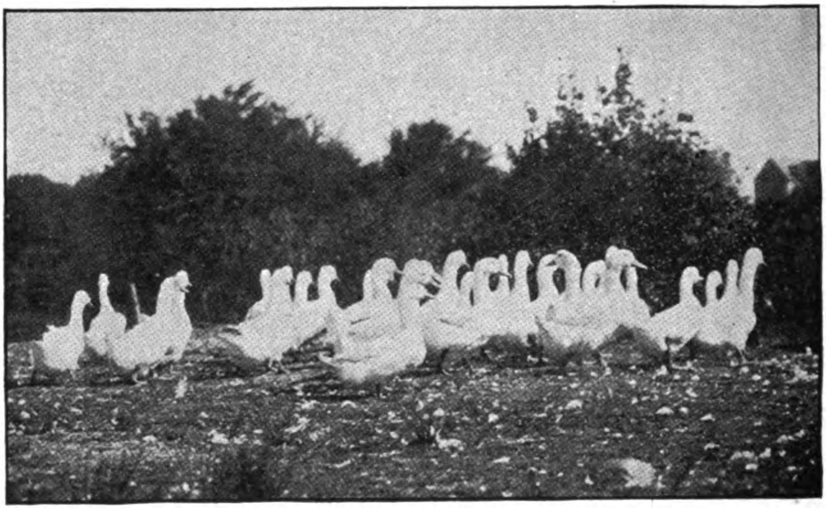


Fig. 429—FLOCK OF PEKIN DUCKS
(R. I. Expt. Sta.)

The opinions of practical duck raisers vary to a considerable extent with regard to the requirements for successful rearing of these birds. Some specialists maintain that free range and plenty of water for bathing purposes are required in order to keep the ducks in good health and in order to secure a satisfactory percentage of fertile eggs. Other equally experienced duck raisers have been very successful when the birds were kept confined and were never allowed access to water except for drinking purposes. In fact, Rankin claims that he has obtained a larger percentage of fertile eggs from ducks in confinement than from those allowed free range. The same author recommends that ducks should not be allowed access to water, and claims to have obtained better results when they were confined without water except for drinking purposes. Duck yards and pastures should be plowed occasionally and planted to forage or other crops. The befouling of yards and the development of disease will thus be in a large measure avoided. In the intervals between the cultivations of the soil the yards may be littered with coal ashes, sawdust or other similar material. Cleanliness in duck yards and houses is of great importance for success with these birds. While ponds or running water may be considered unnecessary for successful duck raising, water must be supplied for drinking. The water should be kept in receptacles where it cannot be easily soiled by the birds, and should be renewed 2 or 3 times per day. Ducks are seldom attacked by hawks; their chief enemies are foxes, rats, minks, weasels, etc. For breeding purposes 5 or 6 ducks should be placed with each drake early in the spring. Later in the season the proportion may be increased to 10 or 12. According to experiments at the Canada Stations the best results are obtained with drakes not over 2 years of age.

Breeds—A large number of breeds of ducks have been produced, but only about 4 are of great economic importance. The remainder are fancy breeds and cannot be made to yield a profit under ordinary circumstances.

The Pekin (Fig. 429) is undoubtedly the most popular breed. It makes the most rapid gains in weight, lays eggs earliest in the season and lays the most eggs. This breed may lay 140 eggs per season. It is probably the most hardy and thrives well without water for bathing purposes. The feathers are white and of most value. Best market prices may be obtained for white birds. This breed is reared in larger numbers than any other. They mature early and are extensively reared for the production of so-called "green ducks." The standard of weight for the drake is 8 pounds, and for the duck 7 pounds.

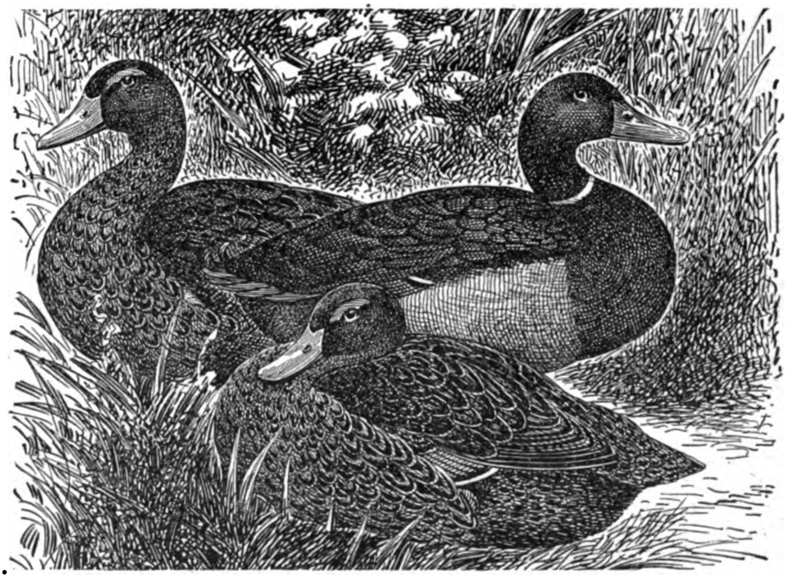


Fig. 430—ROUEN DUCKS

The Rouen (Fig. 430) is highly prized for the flavor of the meat, which perhaps surpasses that of any other breed. As already indicated, they closely resemble the wild Mallard in color. The weight may exceed that of Pekins by 1 pound, but it is generally considered that they do not make as rapid gains as the Pekin.

The Aylesbury (Fig. 431), like the Pekin, is a white duck, and is especially popular in England and European countries. They are of large size, sometimes weighing 10 pounds, and the females 8 pounds. It is comparatively hardy, a prolific layer, and the soft white plumage is considered one of its many attractions.

The CAYUGAS are black in color. According to some breeders they make as rapid gains and come to maturity as early as the Pekins. They thrive well in confinement and are to be considered profitable farm ducks. The standard weight is about the same as for Pekins.

The majority of the other artificial breeds of ducks are noted for their beauty of color, or striking ornamentations upon the head or elsewhere. Usually, however, they are deficient in hardiness and prolificacy, and are therefore not to be selected for practical purposes.

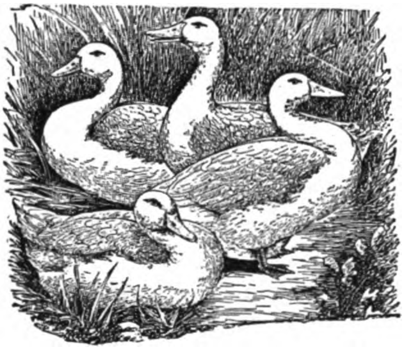


Fig. 431—AYLESBURY DUCKS

Eggs and Hatching—Ducks are seldom good sitters or mothers, and as a rule natural incubation must be by hens. The use of incubators for hatching duck eggs is as successful as with hens' eggs, and specialists in duck raising depend almost exclusively upon artificial incubation and brooding. The most suitable breeds of hens for incubating ducks' eggs are Plymouth Rocks and Brahmas. A hen caring for a brood of ducklings is seen in Fig. 432. The period of incubation is 27 or 28 days—rarely 30 days. No great variation in the period of incubation is observed when the eggs are hatched in artificial incubators. Under hens, however, they may be exposed at times by the hens leaving the nests and thus be somewhat delayed in hatching. The different breeds of ducks lay from 100 to 140 eggs during the season. After 3 or 4 days' incubation the eggs should be examined to determine whether or not they are fertile. At this time the fertile eggs are recognized by the presence of a black spot, which remains upon the upper side of the yolk and rapidly increases in size from the fourth day of incubation. Sterile eggs, as may be seen by holding them toward the light, are clear. They should be removed at the end of the fourth day, or as soon as recognized, and may be used as food or may be sold to bakers. The fertility of duck eggs is highest in the spring; after ducks have been laying for a long time, especially in the midst of the hot season, the fertility is largely reduced. In some cases only 50 per cent are fertile. Forced feeding of breeding stock also reduces the fertility.

Feeding Young Ducklings — Some practical duck raisers recommend that no feed should be given for the first 24 hours. Ducklings may then be fed stale bread moistened with milk, with or without an admixture of bran. Ducklings should not be given milk to drink, since they smear themselves with it and cause the feathers to fall out. Perhaps the best green food is rye, grass or cornstalks, cut fine. Young ducklings as well as old ducks, unlike hens, eat the stalks as well as the leaves, provided they are cut fine. At Ontario College good results were obtained by feeding for the first 2 weeks equal parts corn meal, wheat bran and middlings, and for the next 4 weeks 2 parts wheat bran and 5 parts middlings. At the Canadian Stations another ration was recommended consisting of corn meal mash, hard-boiled eggs and ground wheat or oats, the whole to be mixed with boiled milk, for the first 3 or 4 days. Chopped clover, lettuce or cabbage may be mixed with the mash. With this ration skimmilk was given to drink and the ducklings were fed 5 times per day. After 3 or 4 weeks ducklings may be fed house waste, ground bone, beef scraps and cooked meat. At the end of 9 weeks they should weigh 4 pounds

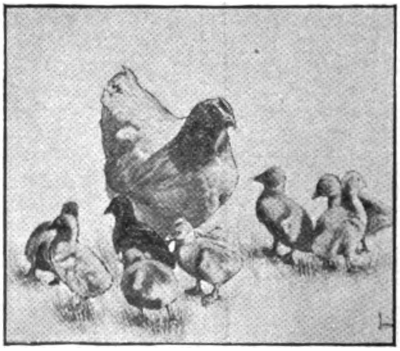


Fig. 432—HEN WITH BROOD OF DUCKLINGS

and should be marketed before the pinfeathers grow. In this condition they are known as "green ducks." At the Ontario Agricultural College ducks 3 months of age weighed 5½ pounds.

The very great value of animal feed for ducks was strongly brought out in experiments reported by the New York State Station. At that station a ration was fed in which 2-5 to ½ the protein contained was derived from animal meal. This was compared with a ration containing the same amount of protein but derived wholly from vegetable sources. At 7 weeks of age the ducklings fed the animal meal ration weighed 3 pounds each and on the contrasted ration 1 pound each. At 9 weeks of age the ducks on the animal meal ration weighed 4.5 pounds each and on the contrasted ration 1½ pounds each. At 11 weeks of age the weights were 5 pounds each on the animal meal ration and but 2 pounds each on the other ration. In this experiment the average weight of 3 pounds each was reached 8 weeks sooner by the ducklings fed the animal meal ration than on the contrasted ration.

In another experiment at the same station ducklings fed a ration made up wholly from vegetable sources failed to thrive and nearly one-half the flock died before they were 4 weeks old and the gains were very small. Similar ducklings getting meat meal in the ration all lived and thrived. When bone ash was added to the ration of vegetable origin so that the mineral constituents were equal in quantity to that contained in the animal meal ration, the gains were better than on a grain ration alone, but were still inferior to the gains made on the meat meal ration. From these and other experiments at the station, in which 170 ducklings have been experimented upon, it would seem that animal matter, either in the form of meat meal or ground bone, fresh meat, or some other form, is absolutely essential to the healthy and rapid growth of ducklings.

Ducks gain much more rapidly in weight than chickens. At the Michigan Station 39 ducks 2 weeks old and weighing a total of 13.25 pounds were fed in comparison with 39 chickens weighing a total of 7.5 pounds. At the end of 5 weeks the ducks had made a total gain of 108.75 pounds and the chickens but 22.5 pounds. It cost but 1.9 cents to produce a pound of gain with the ducks, while the cost with chickens was 4.84 cents per pound of gain.

Feeding Old Ducks—It should be remembered that ducks, like geese, do not possess a crop, and that consequently their food should be softer than chicken feed. Hard food should not be given in any large quantity. Grain must be considered an important part of the ration, but should be ground fine and moistened. In fattening, the best returns are obtained from green ducks, and in general satisfactory profits are only made with comparatively young ducks. Old ducks are not profitable feeders. Rankin recommends 2 meals per day in autumn and early winter of a ration containing corn meal, wheat bran, boiled potatoes, turnips and 10 per cent of ground beef scraps. At noon dry food may be given, such as cracked corn, oats and wheat. In early spring when the ducks begin to lay the corn and animal food should be increased and the amount of wheat should be less.

For producing increase in weight without fattening, good results are obtained from feeding barley meal with plenty of green food. For fattening, the Canadian Stations recommend corn meal, ground grain, beef scraps and barley meal. Experiments at these stations indicate that no better results were to be obtained when the feed was mixed with boiling water than when moistened with cold water. At the New York State Station better results were obtained when animal food was given than when ducks were kept on an exclusively grain and vegetable diet. When ducks are allowed to range freely they feed extensively on insects, snails and other aquatic animals, and thus the need for animal food should be replaced by ground meat when the birds are confined. At the North Carolina Station good gains were obtained in the weight of ducks by feeding a ration of corn meal, wheat bran, cut bones, green clover, with a supply of crushed oyster shells, or other grit.

Marketing Ducks—The general directions given under *Chickens* (see *Chickens*) for shipping alive apply also to ducks. Ducks should be fasted 18 to 24 hours before killing. They are killed by running a sharp knife through the roof of the mouth and then hung up to bleed. Ducks are dipped in boiling hot water in the same manner as chickens. They are more difficult to pick than chickens and hence must be dipped longer. Sometimes they are wrapped up in a blanket and left to steam for a few minutes after dipping. The head and upper portion of the neck should be left unpicked. The legs, feet and entrails are not removed. Ducks should not be singed, as it leaves the skin oily. Ducks are plumped by dipping for an instant in water nearly boiling hot and then in ice cold water, where they should be left 15 to 20 minutes. A very satisfactory package for dressed ducks is a box 30x20 inches and about 10 inches deep. Two or 3 layers can be put in such a box. The ducks may be packed either back or breast down on the bottom layer, but the top layer should be breast up. Slovenly dressed ducks will scarcely pay the expense of shipping to market, but there is a good demand for nicely dressed ducks.

Diseases—Ducks are sometimes attacked by a form of cholera very similar to fowl cholera. Death takes place after about 24 hours. Some benefit is derived from giving carbolic acid (1 per cent) in drinking water, and 1 teaspoonful of the following mixture per quart of soft feed: Rhubarb 5 parts, powdered chalk 5 parts, cayenne pepper 3 parts.

For other diseases of ducks see under *Chickens*.

For further details on duck culture consult "Our Ducks," by F. H. Yorke, "Natural and Artificial Duck Culture," by J. Rankin, and U. S. Dept. Agr. Farmers' Bul. 64.

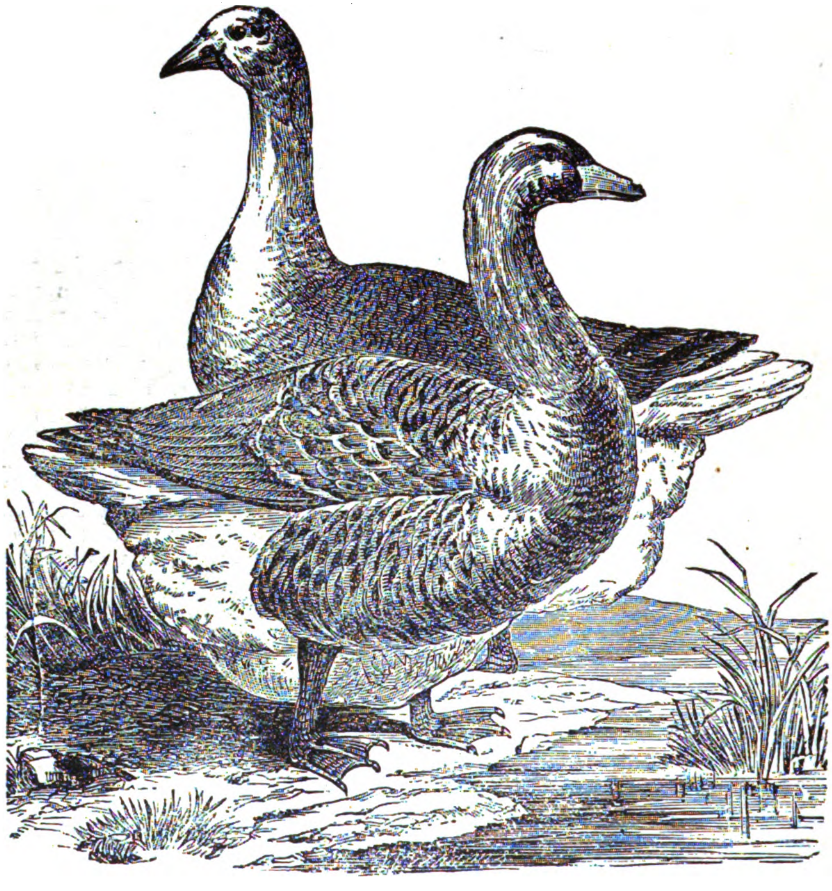


Fig. 433—PAIR OF TOULOUSE GEESE

GEESE

The raising of geese is necessarily conducted for the most part on a small scale. This is due to the requirements of the birds with regard to range and also to their breeding habits and the necessary expense connected with maintaining a large establishment for rearing them. Since the birds are the most strictly monogamous of all domestic fowls, it follows that a large number of expensive ganders would be necessary for conducting the business on any extensive scale. As a rule ganders mate with only 2 or 3, or rarely 4 geese.

Two common breeds of domestic geese, the Embden and Toulouse, are probably descended from the Graylag goose of Europe, while the Brown and White China have apparently descended from the Asiatic wild goose. Geese have undergone comparatively little variation under domestication. Their white color is apparently the result of careful selection and is preferred on account of the greater value of white feathers and on account of the better market appearance of white birds. A great improvement in weight has been accomplished by domestication. European wild geese usually weigh about 10 pounds, while domesticated ganders have attained a weight of 35 or more pounds. The wild Canada goose is easily domesticated and the ganders mate with domestic geese. The crosses thus obtained are known as mongrels and are sterile. They are highly prized in the market and bring larger prices than any other geese. For crossing with wild geese female Toulouse or Africans are usually selected. The rearing of the wild Canada goose or its crosses is accompanied with considerable difficulty, and can only be accomplished successfully after some experience.

As already stated, geese require extensive range. They thrive on green pasturage and water, even without the addition of other food to their diet. It is practically impossible to rear goslings without a liberal supply of green vegetable food, such as clover, roots, cabbage, etc. Geese have no crop like that of hens and turkeys, and as a result they require more soft feed, and food should be given at more frequent intervals. Geese do not become fully mature until the second or third season and good results of breeding should not be expected from younger birds. Under favorable conditions they live to an extremely old age, frequently ranging from 50 to 75 years, and some instances are recorded where they have exceeded 100 years of age. Good geese may be profitably kept for breeding purposes until 25 years of age, but ganders should not be kept past 7 or 8 years. They should then be replaced with younger birds. Both sexes are feathered almost exactly alike, but they are distinguished by differences in voice, length and form of the neck, and size of the head.

Breeds: TOULOUSE (Fig. 433) is perhaps the heaviest breed. It matures slowly and requires a thorough fattening in order to look well on the market. This breed is characterized by an abdominal pouch. Toulouse geese usually lay more eggs than Embden or African and fewer than the China varieties. They are gray in color, with a square body carried horizontally. The general color shades into white on the abdomen. The standard weights are 25 pounds for the gander and 23 pounds for the goose.

The EMBDEN (Fig. 434) resembles the Toulouse in form, but is of pure white color. The body is carried a little higher from the ground. This breed lays somewhat earlier than the Toulouse and the eggs are heavier but not so numerous.

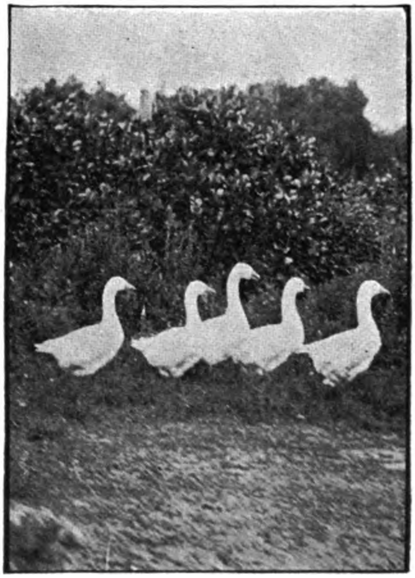


Fig. 434—FLOCK OF EMBDEN GEESE
(R. I. Expt. Sta.)

The AFRICAN matures earlier and makes rapid gains when feeding. They have a more erect carriage than the Toulouse or Embden and less so than the China breeds. The head bears a knob near the base of the bill and there is a dewlap under the throat. The color is dark gray and a brown stripe extends down the back of the neck.

The BROWN and WHITE CHINA (Fig. 435) are smaller than the birds just mentioned, the Brown China gander weighing 16 pounds and the goose 14 pounds. The body is carried in a very erect position. The China birds are early, prolific layers. At the Rhode Island Station they laid in every month between January and June.

The CANADA wild goose is raised in domestication perhaps to a greater extent than the China breeds. The gander weighs about 16 pounds and the goose about 14 pounds. The legs are bare a short distance above the joint. The head and parts of the neck are glossy black, and the rump and tail feathers are of the same color; the upper parts are grayish-brown. This goose lays from 6 to 9 eggs per season.

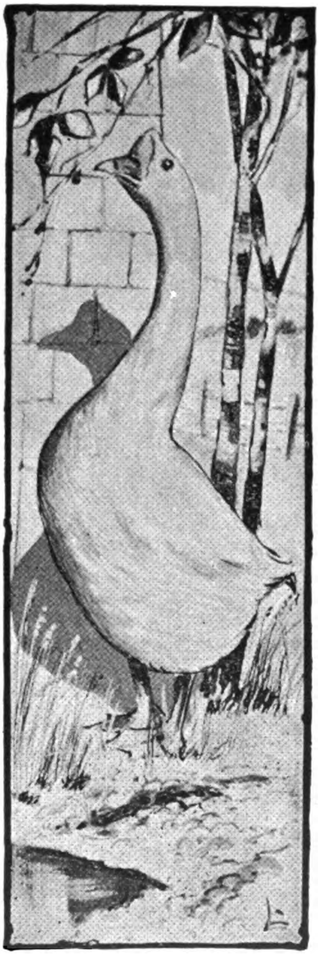


Fig. 435—WHITE CHINA GANDER

Management—Experienced geese raisers realize from $2 to $7 per year from each breeding goose. It will be seen from these figures that geese may be even more productive than sheep. This is chiefly due to the rapid gains which young geese make when fed on a fattening ration, and to the high prices which are obtained for so-called "green geese." Green pasturage is absolutely essential to successful geese raising. Where available space for free pasturage is not to be had the birds must be fed on cut green vegetable food of various sorts. The presence of running water is considered desirable or necessary by many breeders, and plenty of clean drinking water is essential under all conditions. Old birds lay more eggs and are better breeders than young birds. For breeding purposes, ganders of not more than 5 to 8 years are most profitably mated with old geese. Formerly the practice of picking live geese was much more profitable than at present. The market for feathers is less constant and satisfactory than in previous years. In some parts of the country live geese are occasionally picked at present. They should never be picked during the summer, since it interferes with their growth and gives them a less desirable appearance for market purposes. About 1 pound of feathers may be obtained annually from a goose. They should be picked at a time when no blood flows from the ends of the quills.

In breeding mongrels 1 wild Canada gander should be mated with a single African or Toulouse goose. The gander should be 2 or 3 years old. Mongrels are best fattened during cool weather in late autumn.

Numerous crosses have been produced between different pure breeds of geese. Cross-bred wild and African geese are seen in Fig. 436. Several of these crosses excel other geese in particular directions. The African and Brown China ganders are recognized as the surest breeders, while the Brown and White China females are the best layers. According to the experience of many raisers the Embden make perhaps the best sitters and mothers. The Embden-Toulouse cross is most acceptable in some markets and at the Rhode Island Station was found to weigh most of all crosses which were tried. As already indicated, white birds are most desirable for market. The meat of such birds is whiter and has a better appearance.

Hatching—The different breeds of domesticated geese lay from 16 to 50 eggs per season. In recent experiments in Rhode Island the average number was 13. The period of incubation is from 28 to 34 days, or rarely 40 days. The eggs may be hatched by hens, geese, or artificial incubator. As a rule goslings should not be hatched before the appearance of green grass, since food of this kind is quite necessary to their healthful and rapid growth. During incubation the eggs should be sprinkled with warm water 2 or 3 times during the last week. If the eggs are placed under hens for incubation they may not be covered so successfully as under the mother goose and some delay in hatching may occur. In Rhode Island the fertility of the eggs varied from 31 per cent in the Toulouse to 75 per cent in the Brown China.

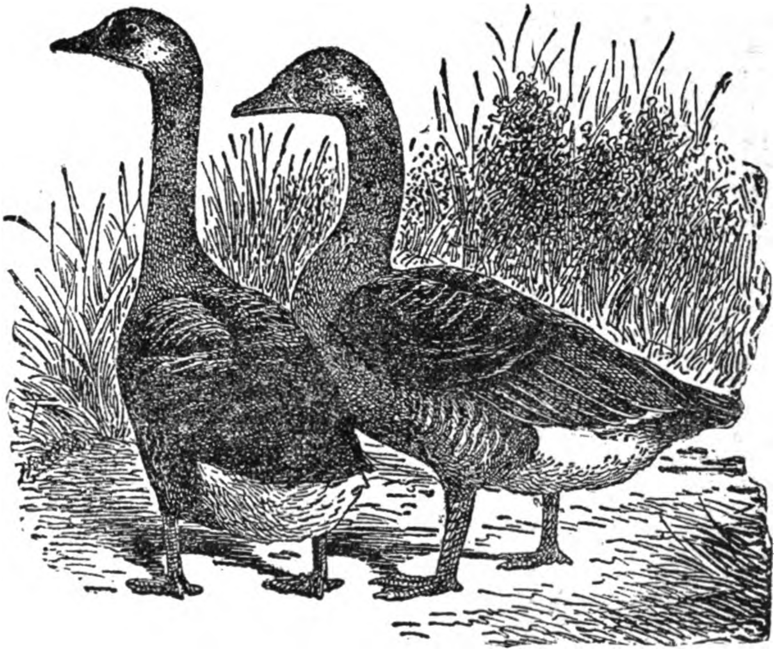


Fig. 436—CROSS-BRED WILD AND AFRICAN GEESE

Feeding Goslings—For the first 3 days they may be fed the same ration as recommended for ducklings. At the Rhode Island Station the best results were obtained when they were given nothing but grass for the first 2 days, then a light feed of scalded cracked corn 3 times per day, with grass, and water to drink. Young goslings, especially if hatched early in the season, should not be allowed access to water for swimming until 2 or 3 weeks old. They may become chilled and much checked in their growth, or may die as a result of such exposure. After the weather becomes warmer and the goslings have become well covered with feathers they may be allowed to swim in pools of running water. During the first few weeks shade should be furnished for protection during the heat of the day. Pure and fresh drinking water should always be kept in a convenient place.

Feeding Breeding Stock—At the Rhode Island Station good results were obtained from feeding breeding geese during the laying season twice a week with a ration of cooked mash containing 2 parts corn meal, 2 parts wheat bran, 2 parts wheat middlings and 1 part beef scraps, the whole mixed with boiling water. During the same period they were fed whole grain, oats and wheat twice per day; crushed oyster shells, waste cabbage and other vegetable food, as well as salt and charcoal were also given. According to some practical geese raisers a good ration for breeding stock consists of equal parts of bran, middlings and corn meal; in addition to this feed the ration should contain 5 per cent of animal food and 10 per cent of green vegetable material.

Feeding for Market—Geese intended for fattening should be confined on dry soil. They may be fed upon scalded dough made of corn meal and fresh beef scraps. From experiments at the Rhode Island Station it is recommended that the corn meal and beef scraps should be of the best quality and should be mixed in the proportion of 1 part of scraps to 4 parts of meal. A small quantity of salt should be added to this mixture, as well as a little powdered charcoal, about twice per week. Water should be supplied in fresh condition at least 3 times per day. Ordinarily no green food is given for the first day or two of the fattening period. The geese should have a constant supply of crushed oyster shells, or other grit. Some authors claim that white flint corn or white corn meal produces a flesh and fat of a whiter color. The ration recommended above should bring goslings to a market condition within a period of from 17 to 20 days. As they are confined during this period and fed forced rations, their appetites may fail if the feeding is continued much longer. The feeding of "green geese" should begin when the large feathers of the wings have attained a sufficient length to reach the tail. In fattening young geese it is generally recommended that they should be placed in small pens which do not allow much exercise. They should be kept as quiet as possible and protected against all disturbances. At the end of the ninth week of age they should weigh between 8 and 10 pounds, and should be in proper condition for market. In Rhode Island the average weight of goslings at 10 weeks of age ranged from 4¾ pounds (Embden) to 7½ pounds (White China).

Another regimen of feeding for fattening includes a ration of barley meal and corn meal soaked in buttermilk, with liberty to run on green pasture. The pasture may consist of oats, rye, clover, rape, or other forage crops. When fed late in the season, cabbages, sorghum and various kinds of roots may be given together with the barley meal and corn meal. This system of feeding is especially applicable to older geese.

Marketing Geese—Geese should be left 12 to 18 hours without food before killing. They are killed and bled by cutting through the roof of the mouth to the brain. They require longer scalding than chickens to loosen the feathers effectually. Sometimes after scalding they are wrapped in blankets for a few minutes to retain the steam and further loosen the feathers. As in the case of ducks the head, feet and entrails are not removed and the feathers are left on the head and a little of the neck. They are plumped by dipping in hot water a little below boiling and then in ice cold water, where they are left 40 to 60 minutes.

When geese are dry picked they should be marketed before cold weather sets in, as after that time the feathers set tighter and in picking them the flesh is likely to be torn. Standard size boxes for shipping run about 30x20 inches and 10 inches deep. As with ducks, there is no profit whatever in sending mussy specimens to market.

Diseases—Perhaps the most serious disease to which geese are subject is cholera. Outbreaks have been observed in a number of States and in Rhode Island a special investigation of the subject was made. It appeared from this study that goose cholera was distinct from fowl cholera. The mortality among the geese was very large. At the time of the outbreak the geese were closely confined in large numbers. For preventing outbreaks of goose cholera it is recommended that fewer geese be placed in each pen and that the pens be so arranged that when the disease appears in one pen, the exposed birds may be quickly separated from the healthy ones. For other diseases of geese see under *Chickens*.

For details of goose raising consult U. S. Dept. Agr. Farmers' Bul. 64, and "Goose Breeding," by C. O. Flagg, in Rpt. R. I. Expt. Sta. for 1897.

GUINEA FOWLS

These birds may scarcely be said to possess economic importance for the average farmer. The meat and eggs of the birds, however, have long been known to be of agreeable flavor, and the fowls are useful for other purposes. If old birds are brought to strange quarters they are almost certain to abandon their new home. It is necessary, therefore, to buy eggs and put them under hens for incubation.

Guinea hens lay from 60 to 100 eggs per season, and the eggs are of a spotted cream color and sharp pointed at the small end. Many poultry raisers testify to the usefulness of Guinea hens as protectors of other fowls. They will attack hawks and other enemies of poultry, and their cries when enemies appear, either by day or night, are useful in giving an alarm. The period of incubation of eggs is 26 days. Guinea hens are not good sitters and the eggs must, therefore, be placed under hens. The young have small crops and should therefore be fed frequently; some raisers recommend feeding every half hour for the first few days. Their food may be the same as for turkeys. Guineas are usually monogamous, but may occasionally mate in the proportion of 1 male to from 2 to 9 hens. A pair of Guinea fowls is seen in Fig. 437.

PIGEONS

The terms pigeon and dove are used interchangeably, referring to all species of the genus *Columba*. In some parts of the country dove is used more frequently than pigeon as the common name of the various domesticated breeds of these birds. Pigeons have been bred by fanciers and for economic purposes to such an extent that a quite unusual amount of variation has been produced. The number of breeds is far in excess of that of other domesticated birds. Many breeds have been produced for the purpose of obtaining birds with peculiar habits, or with peculiar ornaments upon the head, beak, neck or legs, in the way of feathers or fleshy growths. The almost innumerable breeds of domesticated pigeons have all descended from the Blue Rock pigeon (*Columba livia*) of Europe. Various experiments in crossing and the production of varieties have been conducted by Darwin and other naturalists, and these birds have served the purpose of furnishing a basis for many useful scientific conclusions regarding the effects of crossing, in and inbreeding, variation under domestication, and the transmission of acquired characters. This brief account, however, must be occupied merely with the economic side of the question and cannot, therefore, consider the various breeds from the standpoint of a fancier. A fine specimen of Antwerp Carrier pigeon is seen in Fig. 438.

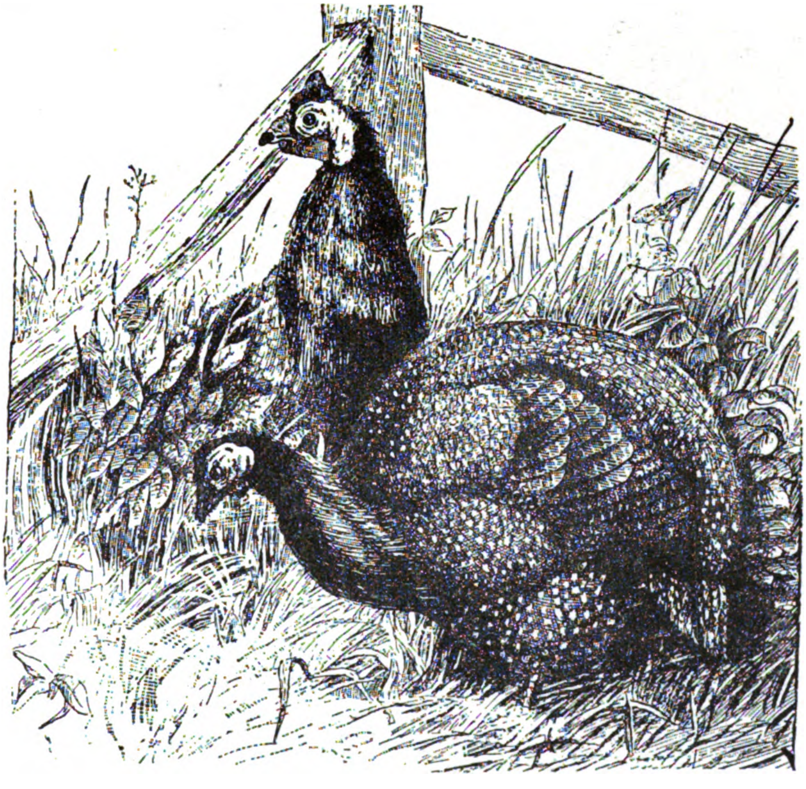


Fig. 437—PAIR OF GUINEA FOWLS

Good market prices are obtained for young, unfledged pigeons, known as squabs, and this has led to their production on a large scale in the neighborhood of cities where a market for these birds has been developed. Pigeon raisers do not all agree as to the most suitable breeds for the production of squabs.

Duchesse, Homer and Dragoon are usually mentioned as most desirable for this purpose, but some raisers prefer crosses between these birds. The Antwerp is frequently mentioned in this connection. Squabs for market should be light colored, and as nearly as possible of a uniform color. Attention should be given to the question of color, therefore, in choosing breeds for the production of squabs. A pair of squabs ready for market is seen in Fig. 439.

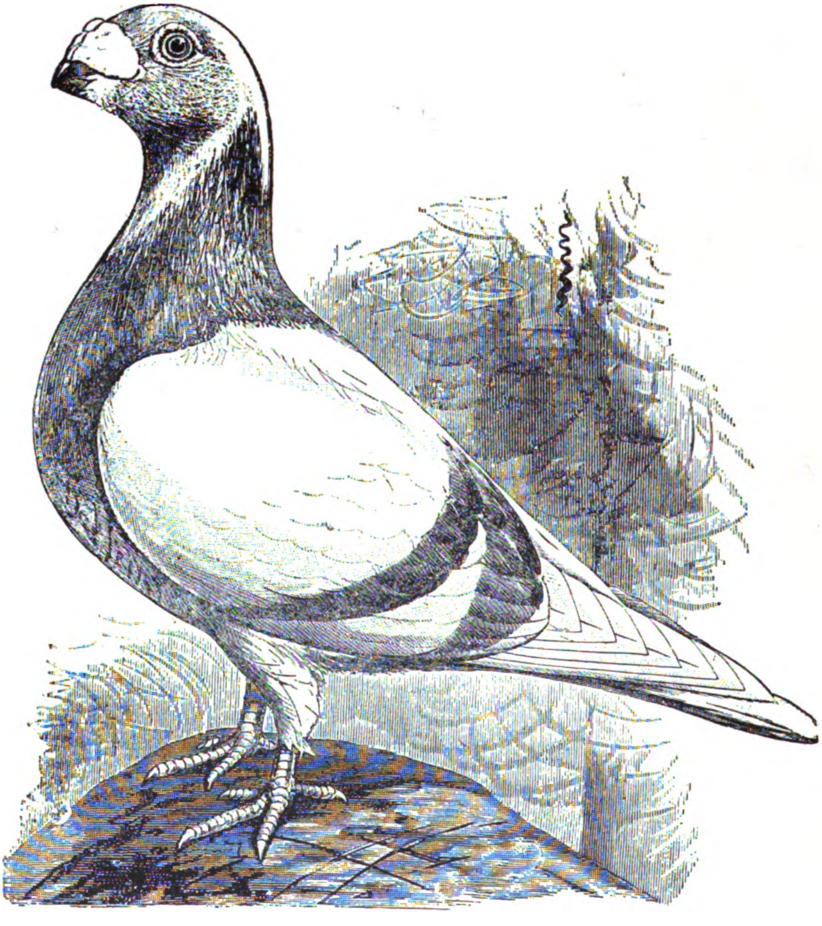


Fig. 438—ANTWERP CARRIER PIGEON

Pigeons lay 2 eggs for each sitting; each female may lay 2 more eggs before the young pigeons of the first laying are fully feathered. The incubation period is from 16 to 18 days. Incubation is generally done by both of the parent birds, the male alternating with the female in covering the eggs. A male pigeon mates with but 1 female. The young are fed by the mothers on so-called pigeon-milk, which is simply the food of the mother after undergoing certain changes in the crop. Young pigeons may also be fed by hand, and for this purpose soaked grain or bread may be used. The squabs should be ready for market at the age of from 25 to 28 days.

Pigeons should be fed in covered boxes furnished with slats so that they cannot soil the food but can easily reach it with their beaks. Experiments have shown that rye, unhulled oats, musty grain, new wheat and new corn should not be fed to pigeons. They should be fed twice a day, in the early morning and in the middle of the afternoon. The feed which is most generally recommended is dry red wheat, dry cracked corn. Clean screenings may be substituted for red wheat. For the sake of variety, peas, buckwheat and millet seed may be given the birds. According to Long and Brinton, hemp seed should be given in the other food about once per month. This seed apparently exercises a medicinal effect on pigeons and appears to serve in keeping them in good health. Dry bread and bran with a small addition of salt may be offered as a substitute for grain. Green food is not necessary, except perhaps an occasional piece of lettuce. Cracked oyster shells should be furnished along with the feed, and water and salt should always be kept convenient. Salt may be given in the form of a piece of rock salt from which the birds can pick as much as they wish.

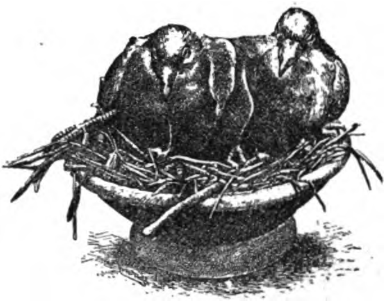


Fig. 439—FOUR-WEEKS-OLD SQUABS READY FOR MARKET

The buildings and plant for pigeon raising will depend entirely upon the extent to which one wishes to engage in the business. They should be kept in dry quarters and a double nest should be provided for each bird during the breeding season. Careful attention should be given to keeping their quarters clean in order to prevent serious infestation from lice. The business of pigeon raising is ordinarily conducted as a mere side line, but may be made to pay reasonable profits if proper attention be given to the necessary conditions.

Diseases—Pigeons are subject to a number of diseases, most of which are also found in chickens and other domesticated birds. For roup, cholera and asthenia see under *Chickens*.

CANKER is a disease of a diphtheritic nature, with symptoms of fever, congestion and swelling of the throat. White patches appear on the mucous linings of the throat and mouth. The disease closely resembles and may be identical with roup in chickens. Affected birds should be isolated at once, and after the canker membranes are removed, the raw surfaces may be treated with powdered alum.

SMALLPOX is a disease that sometimes appears in large flocks of pigeons and is contagious. It appears in the form of sores upon the head, and if untreated spreads over the neck, forming large masses of scabby sores. Affected birds should be isolated and the scabby areas should be treated with a dilute solution of blue vitriol. A few applications usually check the progress of the disease.

WING DISEASE in pigeons is a stiffening of the joints due to a tumor at this point. It may be the result of a strain or injury. If the affection is noted soon after its first appearance, the inflamed spot may be rubbed with strong spirits of camphor or painted with iodin. This treatment usually gives good results.

A considerable number of parasitic worms are found in the intestines of pigeons. Ordinarily the presence of these worms causes no serious disease. If they become too numerous they may be expelled by giving a small piece of garlic once a day or powdered areca nut and a capsule of castor oil.

Pigeons may become infested with lice, of which several species are parasitic on these birds, ticks (*Argas reflexus*) and plume mites (*Falciger rostratus*). For the treatment of infested birds and their quarters see under *Chickens.*

Consult also "The Book of Pigeons," by R. Fulton, and "The National Standard Squab Book," by E. C. Rice.

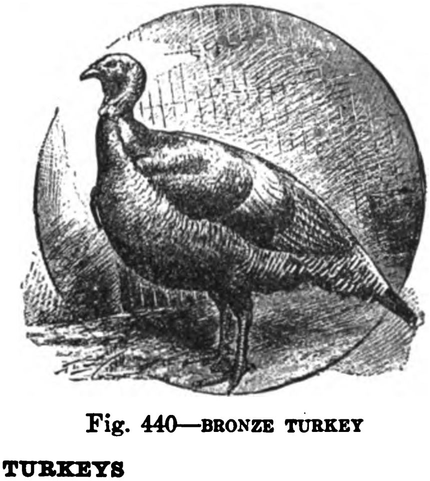


Fig. 440—BRONZE TURKEY

TURKEYS

Turkey raising, unlike chicken raising, cannot be conducted on a large commercial scale by one individual. The nature of turkeys is such that they require a wide range, and the amount of space available for this industry is naturally limited in any particular locality. As a rule, therefore, turkey raising is carried on chiefly by farmers and other persons in a small way, either in the country districts or in the immediate neighborhood of cities. Numerous experiments have shown that it is impossible to raise turkeys successfully in houses or in confinement, as may be done with hens and ducks. Recently experiments were made in South Carolina to determine the effects of confinement on turkeys. It was found that the Bronze laid 42 eggs, of which 27 were fertile, and the White Holland laid 36, of which 16 hatched. As a consequence of the wild nature of turkeys the buildings necessary for raising them are not a matter of much expense. After turkeys have "thrown the red," they require little care and practically no protection from the inclemency of the weather. Experiments in Rhode Island demonstrated that turkeys kept in a more healthful and thrifty condition when allowed to roost in trees than when made to roost in buildings, even with a considerable amount of ventilation. Turkey raising, therefore, simply requires care in feeding and management of the young chicks. After they have become partly developed, the less attention which is given them in the way of buildings and confinement the better for the growth and development of the turkeys.

Domestic turkeys are all developed from wild turkeys. Three species of wild turkeys are generally recognized, one in the United States, another in Mexico, and the third in Central America. Domesticated turkeys are usually supposed to be descended from the Mexican wild turkey. Wild turkeys are frequently domesticated and crossed with the various domestic breeds, especially with the Bronze turkeys. The Bronze is commonly recognized as the most vigorous of all breeds and their vigor is attributed to the frequent crossings which have occured with wild species. Experiments at the Rhode Island Station and by many practical turkey raisers have demonstrated that an occasional cross with wild turkeys adds much to the vitality, vigor and hardiness of the race. Crosses thus obtained are less subject to the common diseases which carry off so many of the domesticated turkeys of low vitality. The hen turkeys obtained from such crosses are found to be wild and less easily managed than the gobblers. Perhaps the most desirable results in size, vigor and hardiness are obtained in crosses containing ¼ wild turkey blood. Wild turkeys are distinguished from domesticated birds by the absence of white feathers, and their neater, more stately appearance and greater hight. Wild gobblers sometimes reach the hight of 4 feet and are often known to weigh 36 pounds. The meat is of a more gamy flavor than that of domesticated birds and this flavor is inherited to some extent by crosses from the wild species.

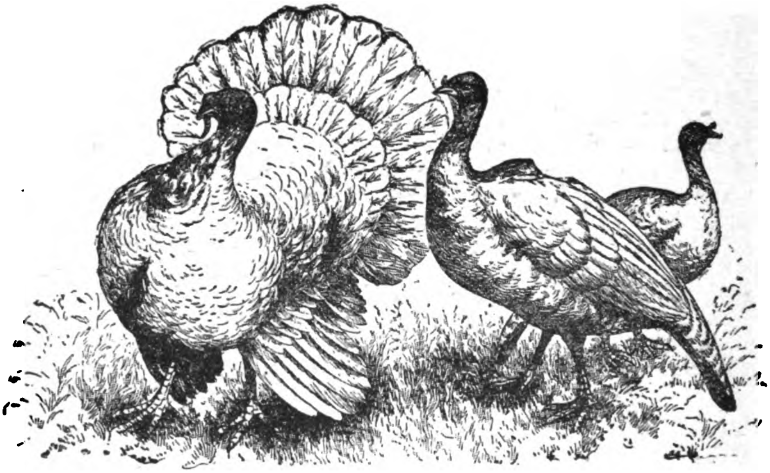


Fig. 441—WHITE HOLLAND TURKEYS

In the habits of turkeys, particularly the females, the influence of wild blood is still noticeable. Hen turkeys, if left to themselves, usually conceal the nest, and some watching is required during the nesting season in order to prevent the destruction of the eggs in nests which are made in out-of-the-way places. The greatest enemies of turkey eggs in such situations are crows, skunks, rats, weasels, etc. Turkeys should lay from 18 to 24 eggs per season. The first 5 or 6 eggs may be taken from the nest and given to hens for incubation, while the remainder may be covered by the mother turkey. Under favorable conditions a large percentage of turkey eggs are fertile. In experiments in Rhode Island, 15 out of every 16 produced vigorous chicks. The incubation period is 27 or 28 days, rarely 30 days. The eggs may be hatched under turkeys, hens or incubators. The heavy breeds of hens, such as Brahmas and Plymouth Rocks, are most suitable for incubating turkey eggs. From 3 to 20 or 30 hen turkeys may be allowed with each gobbler, according to the vigor of the gobbler, and other circumstances. The fertility of turkey eggs may be affected by unfavorable circumstances and improper feeding of breeding stock, in the same manner as described under *Chickens.*

In general it should be stated that more care is required for turkeys in their infancy than for any other domestic fowls, while after they "throw the red," they require little or no attention. Where a wide range is given, as on a farm, the turkeys will naturally wander about in the field during the greater portion of the day, usually making 2 foraging expeditions during each day, with a resting period during the hotter portion of the day. On such expeditions turkeys feed largely upon insects, and where grasshoppers are plentiful they may be expected to maintain themselves in good condition on this food, together with such green food as they may collect. In the fall some care is required in catching the individuals from each flock in order not to frighten the rest of the flock so as to make them wild and suspicious of the presence of man.

The chief breeds of domesticated turkeys are Bronze (Fig. 440), White Holland (Fig. 441), Narragansett (Fig. 442), Slate, Buff and Black. The Bronze is the largest, most vigorous breed, and most nearly resembles the wild species. The adult gobbler should weigh about 36 pounds and the female about 20 pounds. This breed is undoubtedly the most popular, especially in locations where turkey diseases are prevalent, since it is to some extent resistant to these diseases. The White Holland is commonly known as White turkey, and while not generally so popular as the Bronze, is much liked by those who have engaged in raising it. The White turkeys are good layers but occasionally do not want to sit early in the season. The weight of the bird is somewhat less than that of the Bronze. The Narragansett is a noted bird in Rhode Island and elsewhere; in most localities it has been largely replaced by the Bronze. The standard size is somewhat greater than that of the White and less than the Bronze. The Buff, Slate and Black turkeys are sufficiently well characterized by their color. There is apparently little difference between the Buff

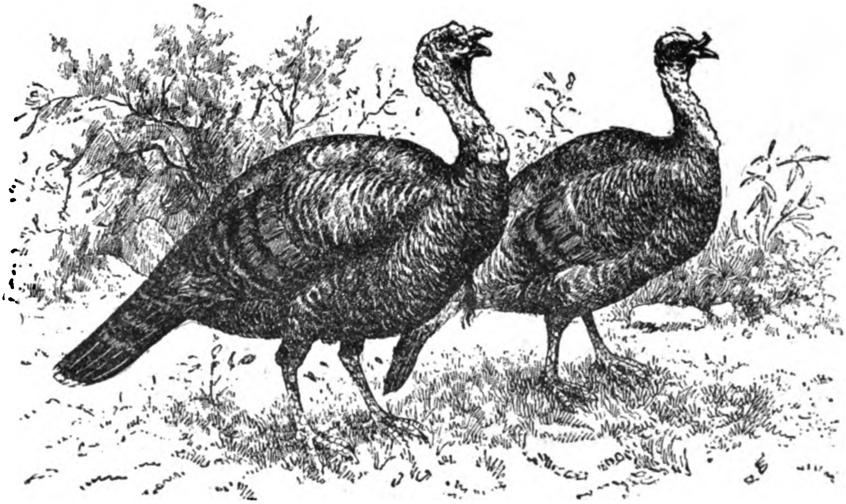


Fig. 442—NARRAGANSETT TURKEYS

and Slate except in color. The Buffs are heavier than the White turkeys and the Black turkey has long been the favorite breed in parts of England.

Turkeys are remarkably good sitters and are extensively used in France and certain parts of the United States for incubating purposes in the place of hens or incubators. They are used in the incubation of all kinds of eggs and with care may be kept at this work almost the year round. They are the most persistent and constant sitters of all the domesticated fowls. In fact when sitting they must be removed daily from the nest and fed, or feed and drink must be placed within reach of them, otherwise they may remain upon the nest without interruption until they are greatly emaciated. They have been known to starve to death under such circumstances.

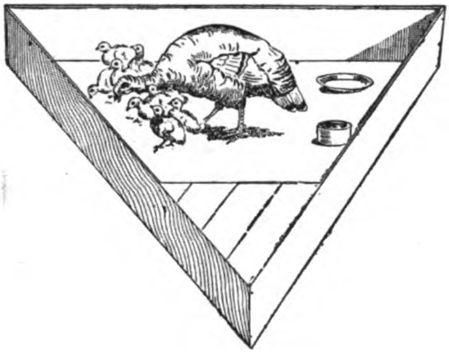


Fig. 443—FEEDING PEN FOR YOUNG TURKEYS

Feeding Young Turkey Chicks—Most turkey raisers recommend that the young chicks should not be fed for the first 24 hours. The first feed of the second day may consist of hard-boiled eggs and bread soaked in hot milk. The bread should be squeezed dry. This diet may be continued for 2 or 3 weeks, with a seasoning of pepper, and with an alternation of milk curds. A convenient pen for young turkeys is shown in Fig. 443. Meal should not be fed dry or incompletely moistened, it might swell in the crop and cause death. Meal should always be thoroughly moistened, either with cold or hot milk or water. It may be fed in the form of corn bread moistened with milk or water. After 3 weeks boiled eggs may be replaced by meat scraps and ground bone.

The young chicks should have green food, such as dandelions, onions, turnips, etc. After they begin to run out, they forage largely for themselves and may be given a feed of buckwheat, cracked corn or wheat, at night upon returning from the field. In this way they will be induced to return every night and will become used to the presence of man and therefore will not develop any wild tendencies. During the feathering period especial care is required in feeding and other attentions. Plenty of chopped meat and ground bone should be given at this period. Turkey chicks, especially the first week or two, must be protected from the rain and dew, must be given scrupulously clean quarters, and plenty of exercise during the warm and dry hours of the day. They should not be fed uncooked food, since young turkeys are especially liable to attacks of diarrhea and this trouble develops more readily when they are fed on uncooked grain or other food.

Other diets for young turkeys have been proposed by various breeders. According to one scheme, during the first few days they should be fed bread soaked in milk mixed with hard-boiled eggs and onion, both of the latter being chopped fine. Sour milk curds should also be given at this time. Later they should be fed on oatmeal, rolled oats or a mash made with corn meal, bread, onion tops and other green food, the whole mixed with boiled skimmed milk and seasoned with a little pepper.

Whatever diet is adopted care should always be exercised to avoid overfeeding. A practical turkey raiser in Rhode Island feeds for the first 4 weeks corn meal mixed with sour milk and gives sour milk to drink. Later, cracked corn is mixed with the milk and the quantity gradually increased until at 10 weeks of age the ration contains simply cracked corn moistened with sour milk. After becoming fully feathered, young turkeys require no feed except hard grain.

Feeding Breeding Stock—In Northern climates breeding stock should be housed in winter, but the houses should have abundant ventilation and the birds must be given liberty during mild weather. The freedom for exercise during moderate weather is probably of more importance than protection from cold during severe weather. The morning feed may consist of a mash containing corn meal, wheat screenings, onions, turnips, beets, etc. Black or cayenne pepper should be added 2 or 3 times per week. Salt should be given rarely, only in small quantities. Clover and other green feeds, as well as crushed oyster shells and other foods containing lime, should be given under the same conditions as recommended for chickens. In the evening one of the best feeds is hot whole grain, heated dry or in hot water. For this purpose corn is probably the best grain. Breeding stock should never be overfed and care should be exercised to prevent their becoming too fat. Excessive fatness in turkeys reduces the egg yield and influences the fertility unfavorably.

Feeding for Market—Turkeys are raised almost exclusively for meat. The number of eggs which they produce is not enough to make it profitable to raise them for the eggs. When the supply of insects in the field runs short in late autumn, turkeys which are intended for fattening should be given a regular ration. In the morning they may be fed bran, corn meal, boiled potatoes, apples, roots, etc., and in the evening they should be given a feed of whole grain. After feeding in this manner for a few days a change to a special fattening ration may be made. The special ration may consist of 3 feeds per day of corn meal and cooked potatoes, with 1 evening feed of whole corn, wheat or buckwheat. Pounded charcoal should be given occasionally and a supply of grit should be kept convenient for the birds. Fresh clean water is absolutely essential to best success. This ration, if given for 20 days, should put turkeys in perfect condition for market. In general, the various food materials, whether animal, green vegetable or grain, have essentially the same feeding value as for chickens. Among the green feeds, however, dandelions are much liked by turkeys of all ages, and it is possible that this plant may have a tonic effect on turkeys. Consult also "Turkeys and How to Grow Them," by Herbert Myrick.

Marketing Turkeys—The directions given under *Chickens* for killing, scalding, picking and plumping apply also to turkeys. (See *Chickens.*) Turkeys, however, should not be deprived of food for more than 12 hours before killing. If starved longer than this they are likely to shrink in weight and the quality of the flesh be impaired.

The best packages are boxes 22 by 26 inches and 14 inches deep. The turkeys in each package should be as uniform in size as possible. The boxes should be lined with clean paper. The individual turkeys should not be wrapped but be packed snugly to avoid bruising in shipment. All heavy toms should be disposed of before January 1.

Diseases—In turkeys, as in other domesticated animals and birds, it is desirable to isolate immediately all sick birds to which suspicion of an infectious disease attaches, in order that the nature of the disease may be determined without danger of its spread to other birds. One of the common diseases of young turkeys is DIARRHEA, which is caused by exposure to cold and dampness or by eating sour, uncooked food and drinking stagnant water. Affected young turkeys should be fed on hard-boiled eggs and stale bread, with plenty of pepper. A mixture containing 2 ounces sulphuric acid, ½ pound copperas, 2 gallons of water, gives good results in the treatment of this disease. The mixture may be kept in a stone jug and may be added to drinking water at the rate of 1 teaspoonful to every quart.

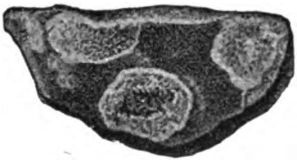


Fig. 444—NATURAL SIZE OF SPOTS ON LIVER

ROUP and GAPES prevail extensively among turkeys. For the treatment of these diseases see under *Chickens.*

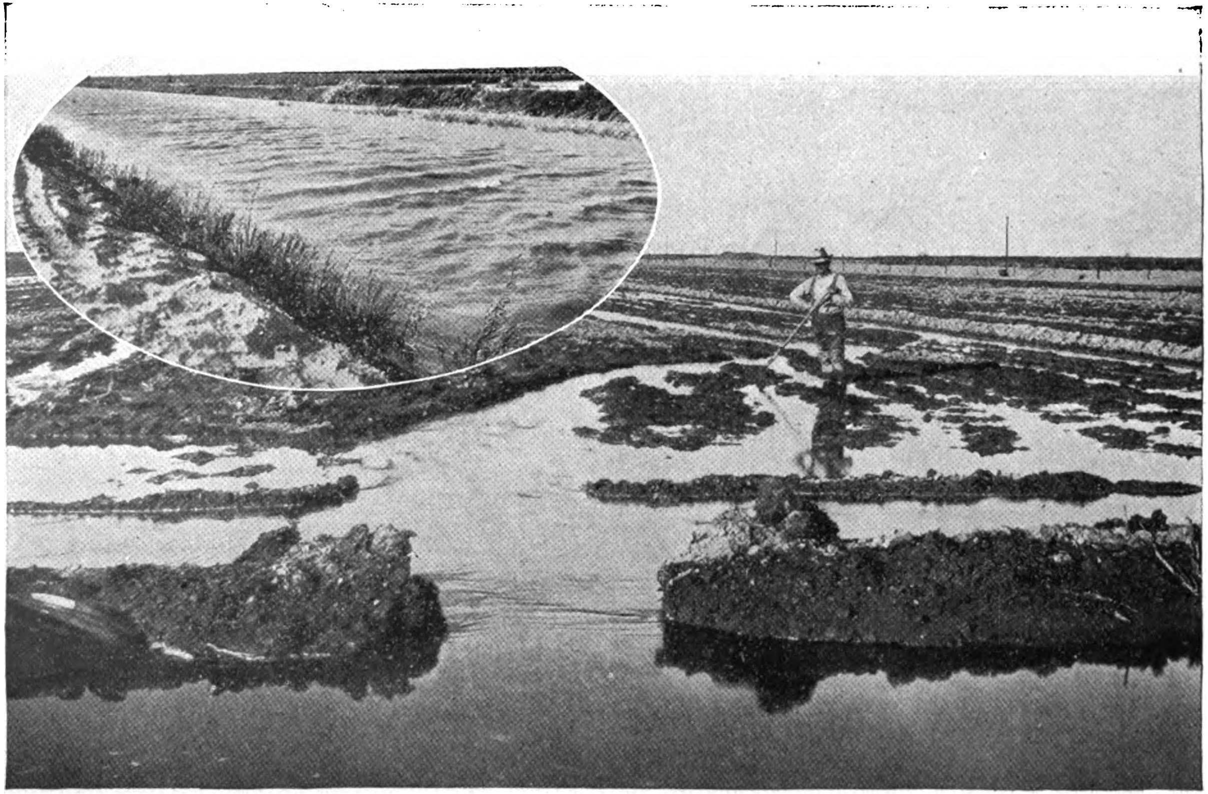
BLACKHEAD is a malignant contagious disease due to the presence of *Amoeba meleagridis* in the intestines. This disease has proved very serious in Rhode Island, and has been investigated by the experiment station of that State and by the Bureau of Animal Industry. The external symptoms of affected turkeys are not always the same. When the disease is at its hight there may be a peculiar discoloration which gives it the name blackhead; but this symptom is not always present. A profuse diarrhea appears during the progress of the disease. Turkeys are attacked while quite young. The primary seat of the disease is in the caeca, or blind finger-like processes of the intestines. These internal structures during the progress of the disease develop very thick walls. After the disease has become well established, the further changes in the intestines may be due partly to the co-operation of bacteria. From the caeca the disease spreads to the liver. This organ becomes enlarged to about twice its normal size. Round discolored spots are to be seen on the surface of the liver. (Fig. 444.) The parasites of the disease are found in large numbers in affected livers. After a certain length of time a regenerative process begins which may lead to permanent recovery, or the disease may progress so rapidly that affected turkeys die while very young. Treatment for the disease must be of a preventive nature. If it has existed for a long time in one place, it is probable that the roosts and feeding grounds are infected, and such places should be thoroughly treated with carbolic acid or disinfectants. Remedial treatment of the disease gives little hope of success, although the administration of tonics sometimes assists the turkeys in resisting the disease. Turkeys appear to be more resistant toward the disease in dry, warm weather than in wet, cold weather. It is probable that the disease is extensively transmitted through the excrement of diseased birds. This material should be collected often and thoroughly and the turkey houses should be dusted with air-slaked lime.

Turkeys are often infested with TAPEWORMS, although these worms are not often present in sufficient numbers to cause a serious drain on the vigor of the turkeys. For expelling tapeworms perhaps the best remedies are kousso and male-fern, which should be administered is small doses. Turpentine given in small quantities on the food is recommended by some turkey raisers.

For TUBERCULOSIS and CHOLERA see under *Chickens.*

PART VII

FERTILIZERS, SOILS, DRAINAGE, IRRIGATION, ETC., ETC.



IRRIGATION METHODS IN CALIFORNIA

FARMER'S CYCLOPEDIA OF AGRICULTURE

FERTILIZERS, SOILS, DRAINAGE, IRRIGATION, ETC., ETC.

DRAINAGE

More or less elaborate systems of drainage have long been put in practice on various kinds of agricultural land. The value and necessity of drainage have perhaps not been so well recognized as those of irrigation in arid regions. The area of arid land which has been reclaimed by irrigation up to the present time probably does not exceed that of swampy regions which could be reclaimed by a proper system of drainage. The purposes of drainage are manifold. In alkaline soils, especially where irrigation is practiced, a system of drainage is the only efficient remedy for removing the excess of alkali from the soil. In swampy land drainage is necessary in order to make the soil sufficiently firm and dry to be cultivated.

In order that the soil condition shall be favorable for vigorous plant growth it is necessary that the texture of the soil be sufficiently loose and the upper layer sufficiently dry to permit a perfectly free circulation of air down to the depths at which the majority of the plant roots are found. A free circulation of air is required in order to carry oxygen, nitrogen and carbon dioxid, all of which are necessary for various reasons to the most active production of plant substance. It will be readily understood that air cannot circulate in soil which is already saturated with water.

By a system of underdrainage the level of the ground water is lowered, the upper layers of the soil become drier, and cracks are formed so that air is admitted more freely. Such ventilation is especially necessary in clay and other heavy soils.

By lowering the level of the ground water in the soil, favorable conditions are furnished for the deeper penetration of the roots of plants, and as a result the plants are better able to withstand drouths which may occur later in the season. The power of the soil for taking up water by capillary action is greatly increased by withdrawing the underlying body of water, and in times of drouth the plants are able to obtain more water for growth than under conditions where the soil was so moist during the early stages of growth that the root development was confined to the superficial layer of the soil. With well-drained soils farm work such as plowing and cultivating can usually be commenced 10 days to 2 weeks earlier in the spring than on undrained land and can be continued that much longer in the fall.

The soil is made warmer by a proper system of drainage. This phenomenon is due to 2 or more effects of drainage. It is well known that the temperature of water is raised with much greater difficulty than that of soil or other dry substances. As the result of removing the water from the surface of the soil by drainage, the soil absorbs more heat in early spring; it is thus possible to sow seed under favorable conditions earlier on drained than on undrained soil. The most important cause of the coldness of wet soils consists in the fact that in such soils the surface evaporation of water is extensive, and the heat which has been absorbed is lost during such evaporation. This is in accordance with the well-known phenomenon that all bodies are rapidly cooled by the evaporation of water from the surface. Observations have shown a difference in temperature varying from 2½° to 12½° F. between drained and undrained soils of the same sort in the same locality. The importance of securing as high a temperature as possible in soils in early spring cannot be overestimated. If the soil is too cool various seeds may fail entirely to germinate, or may produce only weak and stunted plants. With the majority of cultivated plants little active growth takes place until the soil has attained a temperature of 48° F., or higher. The difference in the length of time required for seeds to germinate in cold and warm soils is very striking, and may make the difference between a profitable and an unprofitable crop.

All agricultural soils need drainage, but the majority of them are sufficiently drained by natural means. Experiments have shown that the extent of the profitable application of a system of drainage has perhaps been underestimated. Loose, sandy soils, in which the level of the ground water is very deep, naturally do not require drainage. The same is true of the soils of the arid and semi-arid regions, provided an excess of alkali is not present. In such soils there is no distinction between soil and subsoil, and as a result the level of the ground water is under ordinary circumstances very low. Steep side-hills may be profitably drained with broad open ditches, for the purpose of preventing excessive erosion and consequent loss of the fertile superficial layer of the soil. Those lands which are periodically inundated by floods or are artificially flooded for various purposes, as in the case of cranberry bogs, require drainage in order to prevent stagnation of water in the soil and the exclusion of the various gases of the air. Tracts of land lying somewhat low as compared with the surrounding land and receiving surface drainage or water by seepage from the higher land almost invariably require drainage.

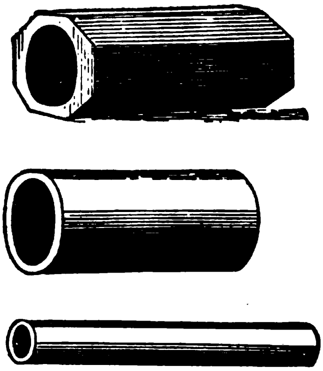


Fig. 446—DIFFERENT FORMS OF DRAIN TILES

There are 2 systems of drainage which are in general use. One consists in digging open ditches which carry the water from the highest part of the land to be drained to the lowest point, where it is discharged; and the other system in the use of tile drains placed at various depths beneath the surface. The use of open ditches is not so satisfactory as tiles, for several reasons. Superficial soil may be washed off into such ditches and lost, and in times of flood they have a tendency to increase the flood rather than to regulate the flow of water. Tile drains, on the other hand, do not increase the hight of spring floods to any great extent, and serve as a check upon floods which may arise later in the season from excessive rainfall. The restraining influence which tile drains exercise is due largely to the greater water absorbing capacity of drained soils.

Tile should be placed at depths varying from 2 to 4 feet beneath the surface, depending upon the character of the soil. In soils which are normally moist during the whole season the tile should be placed at a greater depth, while in soils which are too wet only in the spring it may be undesirable to place the tiles lower than 2½ or 3 feet. The size of the tiles used will naturally vary according to the amount of land which is to be drained. It is generally estimated that a 7-inch tile will successfully drain 60 acres of land. It is ordinarily not advisable to use tiles of a smaller size than 3 inches in diameter, since smaller tiles are very apt to become clogged up by silt. They should be squarely and evenly cut across both ends and without collars, as seen in Fig. 446, and should be placed in close contact end to end. No space should be left between the tiles for the reception of the water; water penetrates the walls of the tiles with considerable rapidity, and if spaces are left the soil may be carried into the tiles and clog them up. Care should be exercised to secure a proper grade for laying the whole series of tiles for draining a given area. With a grade of 2 inches per 100 feet successful conditions are furnished; if the grade is less than that, more care must be exercised in making the grade perfectly uniform, in order to prevent the accumulation of silt at points where the grade changes. The lines of tiles should be laid at intervals of 50 to 100 feet, depending on the character of the soil. The experiments which have been conducted at the stations in various States have shown that profitable results may be obtained from a system of drainage in a great variety of soils. In the sugar soils of the Southern States it has been estimated that more benefit is derived from drainage than from fertilizing. For further details consult Mich.

Expt. Sta. Rpt. 1889; Md. Expt. Sta. Rpt. 1891; Ala. Canebrake Expt. Sta. Bul. 3, Bul. 5, Bul. 6 and Bul. 10, and Cal. Expt. Sta. Bul. 83.

FERTILIZERS

Under this heading will be considered such commercial fertilizers as are usually bought and sold in the market. Farm manures are considered under *Manure,* and such soil amendments as lime, marl, muck, salt and gypsum under their respective headings.

Fertilizers are added to soils to increase the yield of crops. Commercial fertilizers are often called artificials, and some forms are known as mineral fertilizers. They are concentrated forms of fertilizers and sell for $10 to $75 per ton, depending on the amount of plant food contained in them and the availability of those foods for the use of plants. A commercial fertilizer is valuable in proportion to the nitrogen, phosphoric acid and potash it contains. These 3 plant foods are often spoken of as the "essential elements," since they are generally the only ones that need be added to a soil to make it productive, and if any one of these elements be lacking in the soil plants will not grow.

Commercial fertilizers are seldom used on farms west of the Mississippi river; but in many Eastern and Southern States where the native fertility of the soil has been depleted by years of continuous cropping immense quantities are used. They add practically the same elements to the soil that barnyard manure does but in a much more concentrated form. They are easier to handle than barnyard manure, are sometimes cheaper, more rapid in their action, and are often required to supplement barnyard manure which does not always furnish food to plants in the right proportions.

A "complete" fertilizer contains all 3 elements—nitrogen, phosphoric acid and potash. Most of the trade brands of fertilizers sold on the market are complete fertilizers. The amount of each of these elements required by different crops varies greatly. It may be, also, that a soil is already sufficiently fertile in nitrogen to produce a maximum crop, but is lacking in potash and phosphoric acid. It is plain that in such cases a complete fertilizer will not be required. One containing potash and phosphoric acid will be sufficient, and if nitrogen is added it will be of no benefit to the plant and a loss financially. A knowledge of the fertilizer requirements of different plants, of the soils on which the plants are to be grown and of the best forms of fertilizers to apply, therefore, becomes essential to the intelligent use of commercial fertilizers. In this work the most effective fertilizers for use on the different crops have been considered under the plants themselves and need not be considered here.

Only general directions can be given as regards the kind of fertilizer likely to be of greatest value on the different soils. Sandy soils are likely to be deficient in all 3 essential elements. Clayey soils are usually abundantly supplied with phosphoric acid and potash, particularly the latter. Limestone soils generally contain sufficient phosphoric acid. Many black soils are sufficiently rich in nitrogen, but are lacking in potash and phosphoric acid. The only sure way, however, of telling exactly what a soil needs is to grow a crop on it and apply the different elements and combinations on different parts of the field and note the results. There are many different forms of nitrogenous, phosphatic and potassic fertilizers now on the market. The sources, value and uses of some of the more important of these are noted below.

Nitrogenous Fertilizers—The effect of nitrogenous fertilizers is to greatly promote the growth of stems and leaves of plants and to retard the development of flowers and fruit. An abundance of nitrogen in the soil is shown by deep green colored foliage. If nitrogenous fertilizers are applied at about the time the plant should bloom new stem and leaf growth is likely to follow and the blooming period be checked. Even if the flowers should blossom they are likely to be sterile. A lack of nitrogen in the soil is generally indicated by a spindling growth of a yellow, sickly appearance. Nitrogen is the most expensive of the essential fertilizers. It usually costs 14 to 16 cents per pound, while phosphoric acid costs but 5 to 7 cents and potash 4 to 5 cents. The more usual nitrogenous fertilizers found on the market will be briefly characterized below.

NITRATE OF SODA—This fertilizer is also known as Chili saltpeter. It exists in large deposits in Chili and Peru. As put upon the market it is quite uniform in composition, containing about 16 pounds of nitrogen in each 100 pounds of nitrate of soda. It usually retails at from $40 to $50 per ton.

Nitrate of soda readily dissolves in water and is immediately available for the use of plants. Its effects may sometimes be seen within 24 hours. It forms no insoluble compound with the soil constituents, and is therefore easily washed out of the soil when applied in excess of the needs of the plant. For this reason nitrate of soda should not be applied to crops much before the time they will be able to use it, and better results are usually obtained if it is applied in small amounts at 2 or 3 different times during the growth of the plant rather than all at once. It should be applied to the surface soil and lightly cultivated in. Nitrate of soda is one of the most effective nitrogenous fertilizers when properly handled. It should seldom be used in excess of 300 pounds per acre, and ½ this amount is usually sufficient.

SULPHATE OF AMMONIA—This is the most highly concentrated form of nitrogen used for fertilizing purposes. It is formed as a by-product in the manufacture of illuminating gas and contains on the average 20 pounds of actual nitrogen in each 100 pounds of material. It sells for $45 to $60 per ton. It acts less rapidly than nitrate of soda, but much more rapidly than any of the organic forms of nitrogen described below. It is readily soluble in water and easily diffused in the soil. The nitrogen in sulphate of ammonia is about equal in fertilizing value to the nitrogen in nitrate of soda. In a wet season it is likely to be more beneficial than nitrate of soda. Like the latter, it should be applied to the soil in the spring rather than in the fall, and preferably in small amounts as the plants require it. Usually not more than 260 pounds of sulphate of ammonia should be applied per acre, and most crops will not require this amount.

DRIED BLOOD—This is one of the most important of the organic nitrogenous fertilizing materials, as it is the richest in nitrogen and decays rapidly in the soil. It is obtained from the large slaughtering establishments and is made by drying and grinding blood. There are 2 grades, the red and the black. The red blood is the richer in nitrogen and obtained by drying with hot water. The black is dried at a higher temperature and contains but 6 to 12 per cent of nitrogen, while the red contains 13 to 14 per cent. The black blood also contains some phosphoric acid, sometimes as much as 4 per cent, while the red contains but a trace. The nitrogen in dried blood is usually sold at 10 to 11 cents per pound.

AZOTIN, AMMONITE, DRIED MEAT OR MEAL, ANIMAL MATTER—These different terms are applied to a number of very similar products. They are for the most part made up of dried and ground meat, tendons, membranes and other portions of dead animals after the fat has been extracted. They usually contain 10 to 14 per cent of nitrogen, with a small amount of phosphoric acid, and compare very favorably with dried blood as a fertilizer.

TANKAGE is also a fertilizing material obtained from slaughter houses. It is variable in composition, being made up of refuse meat, fats, intestines, including contents, hair, etc. It is usually cooked, dried and ground and sold on the basis of the nitrogen and phosphoric acid it contains. Concentrated tankage contains 10 to 12 per cent of nitrogen and but a small amount of phosphoric acid. Crushed tankage varies in the amount of nitrogen it contains, from 4 to 10 per cent, and may contain as much as 10 per cent phosphoric acid. Crushed tankage has also given good results as a pig feed. (See *Swine*.)

FISH—Fertilizers known as dried fish, ground fish and fish guano are derived from the by-products of fish canning establishments or fish packing houses. They consist largely of the skin, bones and offal. When dried and ground these fertilizers contain 7 to 8 per cent of nitrogen and 6 to 8 per cent of phosphoric acid, and are nearly as valuable as dried blood or tankage.

HOOF MEAL and **HORN DUST** contain 10 to 15 per cent of nitrogen, but are more slowly acting than any of the above animal by-products. The hoof meal appears to be the more valuable material as a source of nitrogen.

LEATHER, WOOL and **HAIR WASTES** are all fairly rich in nitrogen, but it is so slowly available that they have a very low value as fertilizing materials, being often quoted as low as $2.50 per ton. They are sometimes used as adulterants.

COTTONSEED MEAL is the residue which remains after the oil has been extracted from cotton seed. It is a rich cattle food and one of the best of the vegetable nitrogenous fertilizers. It contains about 7 per cent nitrogen, 3 per cent phosphoric acid and 2 per cent potash. The nitrogen is in a less available form than in dried blood and the various meat and fish meals. The whole cotton seed is sometimes used as a fertilizer. It contains considerable oil which has no value as a fertilizer, and is, therefore, not so valuable ton for ton as cottonseed meal. When these products can be obtained at a moderate price they constitute an excellent fertilizer and are largely used in the South.

CASTOR BEAN POMACE is made from castor beans after the oil has been extracted. It contains 5 to 6 per cent nitrogen, 2 per cent phosphoric acid and about 1 per cent of potash, and makes a valuable fertilizer when it can be bought at a reasonable price.

Phosphatic Fertilizers—The role of phosphorus in the growth of plants is not wholly understood, but no plant will grow without it, and it seems to be intimately connected with the production of seed. There are a number of different materials used to supply phosphoric acid to plants, but lime compounds of phosphoric acid are most common. Phosphoric acid exists in fertilizers in 3 forms: "That soluble in water and readily taken up by plants; that insoluble in water, but still readily used by plants, also known as 'reverted'; and that soluble only in strong acids and consequently very slowly used by plants. The soluble and 'reverted' together constitute the 'available' phosphoric acid." Phosphoric acid as it exists naturally in bones and rock is insoluble in water, and only slowly available to plants. When rocks, bones or other materials containing insoluble phosphoric acid are treated with sulphuric acid the phosphoric acid is rendered soluble in water and readily available to plants. Such phosphates are usually known as superphosphates, or acid phosphates, and these are the most valuable forms of phosphatic fertilizers.

Phosphatic fertilizers may be applied to the soil at any time, since they are not washed out by rains or otherwise. The insoluble forms should be applied some time before the crops are sown in order that they may become available for the use of the plants. (See also U. S. Dept. Agr. Farmers' Bul. 44.)

BONES—Ground raw or steamed bones are used largely as phosphatic fertilizers. They contain 3 to 5 per cent of nitrogen and 20 to 25 per cent of phosphoric acid. The phosphoric acid in them is in an insoluble form, but when the bones are ground they readily decay in the soil and the phosphoric acid in them becomes available to the use of plants. The finer the bones are ground the more rapidly they decay, and hence the more valuable they are. The steamed bones contain 1 to 2 per cent less nitrogen than the ground bones, but decay more rapidly in the soil. Bone black or bone charcoal is used first in refining sugar. When it becomes unfit for this purpose it is used as a fertilizer. It may contain 30 per cent of phosphoric acid in a somewhat less available form than fine ground bone. Ground bone and bone meal are usually quoted at prices varying between $20 and $35 per ton.

ROCK PHOSPHATES—These are also known as mineral phosphates and are generally designated by the districts from which they come, as Florida rock, South Carolina rock and Tennessee rock. Other forms of mineral phosphates are the apatites of Canada, phosphatic slags, etc. The phosphoric acid in all these is in an insoluble form, and in the untreated state they are not much used as yet, even when finely ground. They constitute the chief raw materials, however, from which superphosphates or acid phosphates are made. They contain 25 to 30 per cent of phosphoric acid. When finely ground they are often known by the name of floats.

SUPERPHOSPHATES—Also known as acid phosphate, dissolved bone, or bone black, dissolved rock, etc. They are made by grinding bones and the various rock phosphates and other like materials fine and treating with sulphuric acid. This changes the insoluble phosphoric acid into soluble forms which can be readily used by plants. The amount of phosphoric acid in superphosphates varies from 12 to 18 per cent. "The superphosphates made from bone black and bone ash differ from the mineral superphosphates in showing a higher content of 'available' phosphoric acid, an average of 16 per cent, which is practically all soluble." Bone superphosphates contain some nitrogen also, and are sometimes referred to as ammoniated superphosphates, or other like terms.

THOMAS SLAG—Also known as odorless phosphate, phosphoric slag, basic iron slag, etc. This is a by-product in the manufacture of steel and iron, consisting largely of phosphate of lime. The finely ground slag contains 19 to 20 per cent of phosphoric acid, 6 to 7 per cent of which is available. Thomas slag is not used in the manufacture of superphosphates, and should therefore be very finely ground, as the value of the material depends largely upon its fineness.

Experiments in Massachusetts indicate that Thomas slag and dissolved bone black are about equally effective. It appears especially suited for leguminous crops and may be applied at the rate of 600 to 1000 pounds per acre.

Potash Fertilizers—Potash fertilizers are primarily concerned in the production of starch in plants and the development of fruits and seeds. Nearly all forms of potash are soluble in water. The principal materials used as potash fertilizers are the sulphate and muriate of potash, kainit, cottonseed hull ashes, wood ashes and tobacco stems. The potash in all these is about equally available to plants. Potash used as a fertilizer is readily fixed in the soil and is not leached or washed out. It is usually recommended that potash fertilizers be applied broadcast and promptly harrowed in.

MURIATE OF POTASH, now used as a fertilizer, is largely the purified product of German mines. It contains 50 to 53 per cent of actual potash that sells wholesale for 3.5 to 4 cents per pound, or $35 to $40 per ton. A much higher grade is sometimes found on the market. The potash fertilizer is largely used for all farm crops except tobacco, potatoes and sugar beets. With these crops the quality is injured by the use of the muriate.

SULPHATE OF POTASH—This is also a product of German mines. High grade sulphate contains from 48 to 53 per cent actual potash. Some lower grades contain but 30 per cent of actual potash. Sulphate of potash is preferable to muriate in growing tobacco, potatoes and sugar beets. There is a double sulphate of potash and magnesia, also obtained from German mines. These usually contain 26 to 28 per cent of actual potash, and in addition considerable amounts of sulphate of magnesia.

KAINIT—This is the most commonly used crude potash salt of the German mines. It contains from 12 to 14 per cent of actual potash, and in addition considerable amounts of common salt, gypsum and magnesia.

NITRATE OF POTASH, though valuable as a fertilizer for both potash and nitrogen, is seldom used for that purpose, owing to its higher value for making gunpowder. It contains 44 to 45 per cent actual potash.

WOOD ASHES contain when unleached from 4 to 7 per cent of potash in one of the best forms for the use of plants. Leached ashes contain but 1 to 2 per cent of potash. Soft wood ashes are also poor in potash, and coal ashes are practically worthless as regards potash. Wood ashes contain also about 2 per cent of phosphoric acid and 32 per cent of lime. They sell for $6 to $10 per ton. Lime kiln ashes contain on an average but 1.5 per cent of potash and 1 per cent of phosphoric acid. Ashes constitute one of the best forms of potash fertilizers and should be carefully husbanded under shelter away from leaching rains.

COTTONSEED HULL ASHES contain 15 to 25 per cent of potash and 7 to 10 per cent of phosphoric acid, and are therefore a very valuable fertilizer.

TOBACCO STEMS consist of the waste stems and leaf ribs in the manufacture of tobacco. These are frequently ground and sold as a fertilizer. They contain 6 to 7 per cent of potash and 2 to 3 per cent of nitrogen. They have an insecticidal value as well (see under *Spraying*), and are highly valued as fertilizers for tobacco and small fruits.

Home Mixing of Fertilizers—As before noted most of the commercial fertilizers placed on the market are complete fertilizers containing phosphoric acid, potash and nitrogen. The buyer must pay for all these ingredients, although they may not be mixed in the most suitable proportions for the crop he wishes to grow, and it may be that his soil does not require all 3 ingredients. The mixed fertilizers also cost on the average about $10 more per ton than the several ingredients purchased separately. Many farmers have therefore taken to the practice of buying the various ingredients separately and mixing them themselves. It is economy to do so, and generally gives very satisfactory results. The home mixing has an educational value as well.

In buying fertilizers it is usually economy to get the concentrated forms. There is less bulk to handle. They should be in as dry and finely pulverized condition as possible. They handle better and contain a larger percentage of valuable materials than when lumpy and wet. Usually farmers can club together and get reduced rates. In mixing place the bulkiest fertilizer on a tight barn floor first and spread out in a layer 4 to 8 inches deep. On top of this spread layers of the remaining material and then thoroughly mix by shoveling over. If the material is not thoroughly mixed by this method it can be thrown through a sand sieve. The bulk may be increased by adding dry road dust to the heap.

Inspection—In practically all the States where fertilizers are sold laws have been passed which require that each brand put upon the market contain a guarantee as to the amount of phosphoric acid, nitrogen and potash it contains and the form in which it is found. Usually an experiment station officer is charged with the details of collecting and sampling fertilizers put upon the market to see that the laws of the State are complied with. These analyses are published in bulletins from time to time and can be obtained by any farmer free upon application. Such bulletins usually contain comments on the actual cash value of the different fertilizer brands and other valuable information regarding fertilizers. Most States require a license fee for each brand of fertilizer put upon the market.

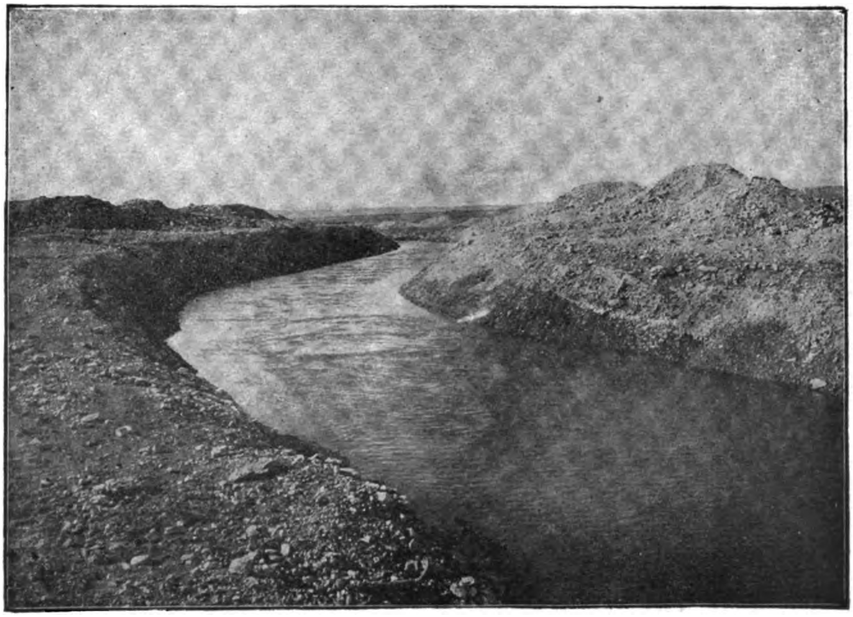


Fig. 447—APPEARANCE OF IRRIGATION CANAL WHEN FIRST COMPLETED
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 105)

The subject of fertilizers is of growing importance in every community. Bulletins on the subject have been published in large numbers by every experiment station and should be obtained and consulted. Some of the more important of these are N. Y. State Expt. Sta. Bul. 94, new series, by Van Slyke, and U. S. Dept. Agr. Farmers' Bul. 44. See also "Fertilizers," by Voorhees, and a larger work, "Manures and Manuring," by Aikman.

GYPSUM

Also known as land plaster, is a sulphate of lime in combination with water. It contains about 33 per cent of lime, 46 per cent of sulphuric acid and 21 per cent of water. When gypsum is burned, water is driven off and plaster of Paris formed. Gypsum deposits are widely distributed throughout the United States. The crude product usually contains some impurities. Gypsum is used to some extent as a fertilizer, but its action is not well understood. It appears to have an indirect action, like lime, in setting free plant food, more especially potash. It has a very beneficial action on clover and other legumes, and was formerly used quite extensively as a manure for these crops. The value of gypsum as an absorbent in stables and manure heaps to prevent loss of ammonia is noted under *Manure*. Its use as an antidote for alkali is discussed under *Alkali Soils*.

Corn and potatoes were formerly often mixed with plaster at planting time for the purpose of hastening germination. Experiments at the New Jersey Stations do not indicate any value for this practice, which is largely being discarded.

IRRIGATION

Irrigation, or the artificial application of water to growing crops, has been known since the dawn of history, in Asia, Africa and Europe. In this country it was first practiced by the Spanish settlers in the Southwest. Near Las Cruces, N. M., there is a ditch which has been in constant use for 300 years. Irrigation by Anglo-Saxons in the United States was first begun by the Mormons in Utah in 1849. Subsequently co-operative colonies in California and Colorado constructed ditches and laid the foundations of successful agriculture in arid regions. Until recently the practice of irrigation has been almost entirely confined to the Western States, and this account will be occupied chiefly with Western conditions.

In order that irrigation may be practicable it is necessary that the streams shall have a large fall; ditches may then be taken out at points along the streams, and by giving the ditches simply enough fall to cause the water to run, the water may be brought to a much higher level than the river, at points a few miles below where the ditch is taken out. If, for instance, the fall of the natural stream is 100 feet per mile and the ditch is constructed with a fall of 4 feet per mile, the water in the ditch at a point 1 mile below where it is taken out will be 96 feet above the river. It is thus possible to bring water by gravity upon high bench lands along the river course. In the Western States the fall of streams varies from 5 to 120 feet per mile, and that of irrigation ditches from 2 to 4 feet or more per mile. It is evident that the greater the fall of the stream the shorter the required length of ditch.

The length of irrigation ditches and canals now in use varies from 1 mile or less to 60 miles or more, and there is, of course, corresponding variation in the cross section of ditches. Ordinary ditches are from 1 to 10 feet in width and the water in them is from ½ foot to 4 feet in depth. Some canals have been constructed which greatly exceed these dimensions. The fall of ditches depends on the natural grade of the land and on the nature of the soil. In localities where the water carries large quantities of silt the ditches become obstructed by such deposits if the water runs too slowly; on the other hand, a too rapid fall is to be avoided on account of the danger from erosion in the bottom and sides of the ditches. The same precautions are to be observed in constructing laterals and irrigation furrows in the cultivated fields. The changes in the appearance

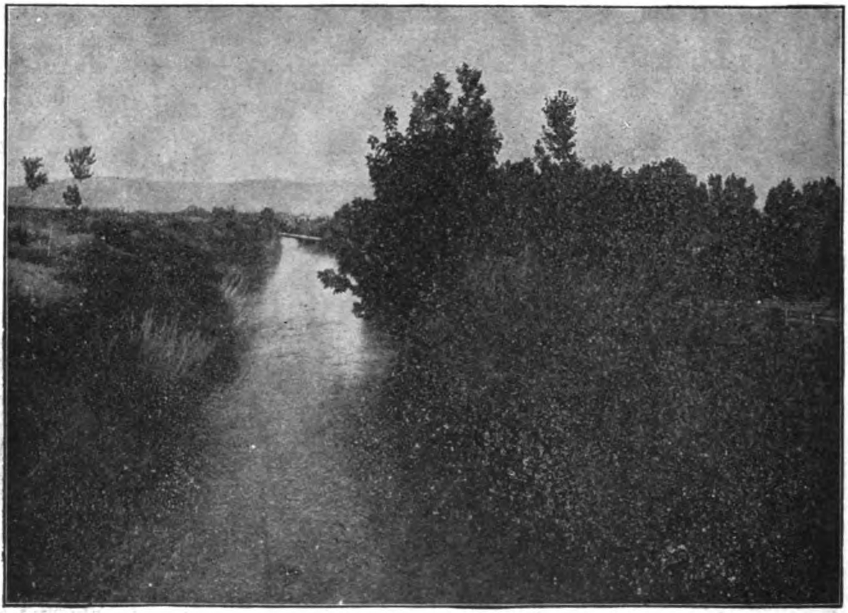


Fig. 448—APPEARANCE OF IRRIGATION CANAL TEN YEARS AFTER COMPLETION
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 105)

of such canals are seen in Figs. 447 and 448.

The construction of large ditches is usually beyond the means of individual ranchers, and these enterprises are commonly carried out by irrigation companies or co-operative organizations of ranchers. Construction work for irrigation purposes has already been done to the value of over $200,000,000. All of this work has been accomplished by private individuals or companies. Until the construction work begun under the recent federal reclamation act, no federal or State aid was given to irrigation enterprises, except a small outlay of State funds in Colorado for the purpose of constructing reservoirs and a canal. low lying agricultural land along the course of the stream. The seepage water may appear lower down, transforming the land into a marsh, or where quantities of alkali are found in the deeper strata of the soil, the alkali passes into a solution in the water, and after being carried to the surface by capillary action, is left as a deposit on the surface of the ground by evaporation of the water.

In estimating the probable velocity of the water in a proposed ditch with a known fall, it should be remembered that with the same fall the velocity of the water in a ditch 10 feet wide is 4 or 5 times as great as in a ditch 1 foot wide.

The original cost of the main ditch and laterals will vary enormously, according to the local conditions, such as character of the soil, slope of the country and required length of the ditch. Where the fall of the natural stream from which water is to be taken is slight, the expense of getting water on adjoining land may be greater than the value of the land will warrant. With the present land values, irrigation by gravity is impracticable along such rivers as the Missouri. In regions where irrigation is practiced on a large scale the cost of getting water on the cultivated fields varies from $2 to $20 per acre. For most crops the actual labor in irrigating is worth from $1 to $1.20 per

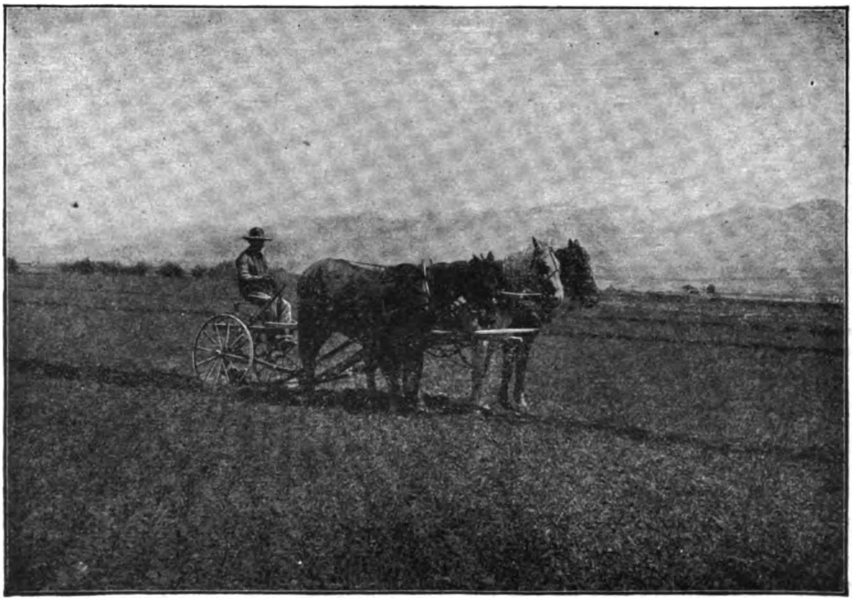


Fig. 449—USING THE DITCH PLOW IN MONTANA
(From U. S. Dept. Agr., Office Expt. Stas., Bul. 86)

In canals of great length the loss of water by seepage and evaporation may become a serious matter. The loss in these directions in a dry atmosphere and a loose soil may amount to 50 per cent of the water taken into the canal at its head. Where the soil is very loose gravel it often becomes necessary to line the bottom and sides of the canal with finer material in order to prevent too great loss by seepage. All irrigation water, however, carries some silt, and canals naturally become lined with this material in the course of time.

Aside from the possible great loss of water, seepage is a source of danger to acre. To this estimate must be added the work of keeping the ditches in repair and cleaning out the deposits of silt. The use of the ditch plow for these purposes, as seen in Fig. 449, lessens the expense very materially.

In arid regions where rainfall cannot be relied upon during the growing season it has been experimentally demonstrated that for bringing field crops to maturity a volume of water sufficient to cover the area to a depth of 2 or 3 feet is required. Several units of measure for water are in use. The miners' inch is the volume which in a period of 24 hours will pass through an opening 1 inch square under a pressure of 6 inches. The difficulties of accurately measuring water by this standard are great, and it has been generally condemned by irrigation experts. It is still in use, however, in a number of States. The cubic feet per second unit for measuring water is simple and reliable. It is an easy calculation to compute the volume of water from the size of the aperture and the velocity of the water. Another unit in general use is the acre foot, or the amount of water necessary to cover 1 acre to a depth of 1 foot, viz., 43,560 cubic feet.

In general, irrigation is necessary for successful farming throughout the country west of the 100th meridian. Stock raising is the chief agricultural industry under a system of irrigation, and probably will remain so. In some regions grains are the chief irrigated crops, in others roots, in still others small fruits and orchards. Any field, orchard or garden crop may be raised by irrigation. There are many valleys in the Western States where, even with a rainfall of 5 inches for the growing season, irrigation is not absolutely necessary, and fine crops of cereals are raised on foothills where it is impossible to get water. But where water is to be had, better crops are raised by using it.

Water is applied either by the flooding or furrow methods. In the case of cereals and forage crops the area is flooded, as seen in Fig. 450. The water is brought into the field in ditches at regular intervals, and by damming the ditches, first at one point and then at another, the field is flooded with water and thoroughly soaked. In irrigating potatoes, beets and other root crops, as well as strawberries planted in rows, the water is brought in laterals to the upper end of the field and allowed to run between the rows. (Fig. 451.) In orchards of deciduous and citrus trees 1 or more shallow furrows are run on either side of each row of trees, as seen in Fig. 452.

Naturally some soils are more susceptible to the dangers of washing than others. On land which is easily eroded and washed away the ditches should be

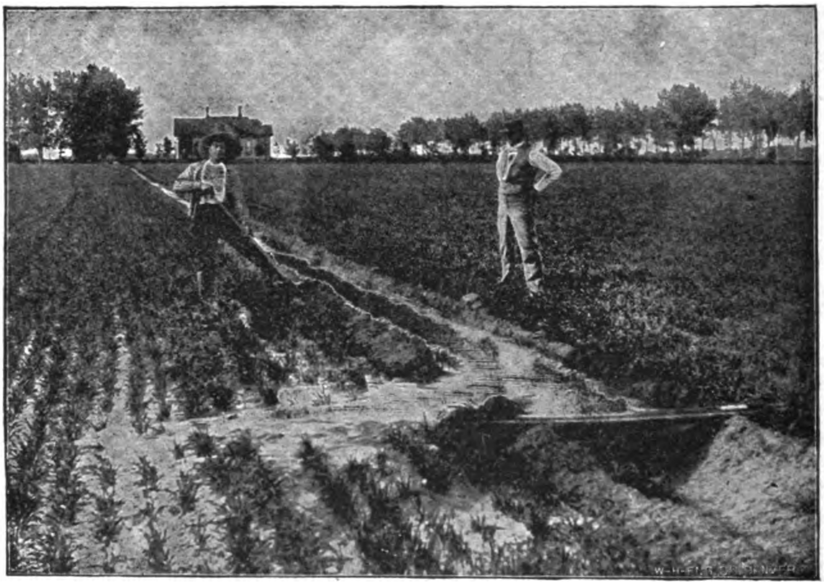


Fig. 450—FLOODING A FIELD OF ALFALFA

surveyed in such a manner as to prevent excessive washing. In loose, deep soils overirrigation sometimes leads to the formation of subterranean channels and caving in of the overlying soil.

The time to irrigate is learned by experience in each locality, for local conditions vary greatly. In general, however, a change in the color of crops indicates their need of water. An examination of the soil reveals at once whether or not it is becoming too dry for plant growth. As the supply of moisture in the soil begins to be exhausted the plants turn a darker green than the normal color, the lower leaves turn yellowish and some of the leaves may droop and curl. When these signs are observed water should be applied at once so as to prevent permanent stunting of the crop. Overirrigated crops develop a sickly yellowish-green color. Where water is plentiful the mistake of using too much is perhaps more frequent than that of not using enough. Inexperienced irrigators sometimes seem to think that irrigation consists simply in having plenty of water and turning it upon the crops, but the necessity of giving close attention to local conditions in successful irrigation is being gradually realized.

Fig. 451—IRRIGATED GARDEN

In areas of field crops which are planted in rows and in orchards and small fruit plats, cultivation of the soil should follow as soon as possible after irrigation, in order to conserve the supply of moisture and prevent caking of the superficial layer of soil. Some soils bake on the surface after irrigation. In such soils irrigation may precede the planting of the crop, if the ground would otherwise be too dry for the germination of the seed. When water is applied soon after sowing time for the purpose of making seed germinate, the ground may be baked so hard at the surface on drying that the grain is unable to stool.

In some localities the area of land upon which water may be taken in ditches is not sufficient to exhaust the available supply of water. On the other hand, there are many regions where the water supply in summer is limited. Here it has been found advisable to soak the ground thoroughly in winter when the water supply is plentiful. It has been demonstrated that the soil may thus be saturated to a depth of from 20 to 30 feet. Since it is well known that the roots of orchard trees and of alfalfa may penetrate 15 or 20 feet into the soil, it is apparent that such plants may obtain moisture without the superficial application of water in summer.

Irrigation on a large scale is made possible in Western States by the regular gradual slope of the land. In the Eastern States these conditions are generally not present and irrigation therefore is of restricted application.

The value of arable land in semi-arid regions is greatly enhanced by bringing irrigation water upon it. In some localities land which cannot be irrigated is worth but $3 or $4 per acre, while adjoining land with water rights is valued at from $20 to $25 per acre. In Southern California, where conditions for raising citrus fruits are favorable, land values have increased enormously under a system of irrigation. In a few such areas land is estimated at $1800 per acre. Literature on irrigation may be obtained from the experiment stations in the States of the Rocky Mountain and Pacific coast region. Still more extensive and valuable are the irrigation bulletins of the Office of Experiment Stations of the United States Department of Agriculture and of the United States Geological Survey. "Irrigation Farming," by Lucius M. Wilcox, may also be consulted.

LEGUMINOUS PLANTS (*Leguminosae*)

An important family of plants, comprising over 7000 species of trees, shrubs and herbs. To this group belong such farm crops as clovers, peas, beans, alfalfa, vetch, melilotus, cowpeas, soy beans, lupines, etc. These crops are especially rich in protein, one of the most important constituents of all feeding stuffs, since it contains the element nitrogen, which furnishes materials for the production of lean meat, muscles, nerves, skin, blood, tendons, wool, hair, casein of milk, albumen of eggs, etc. This makes the legumes especially valuable for feeding to farm animals, in connection with such fat-producing foods as corn, corn fodder, sorghum, grasses, many cereal grains, etc., to make a "balanced" ration.

In addition to this peculiar feeding value of the legumes they possess another characteristic which makes them of the highest value to agriculture. This is the power to utilize in their growth the free nitrogen of the air. It is claimed by some writers that this power belongs to all plants. This may be true, but the legumes possess it in a pre-eminent degree, and are the only plants in which the free nitrogen of the air is utilized in sufficient quantity to be of agricultural importance. The element nitrogen is absolutely essential in the growth of all plants. It is the most expensive element in all fertilizers, costing about 15 cents per pound.

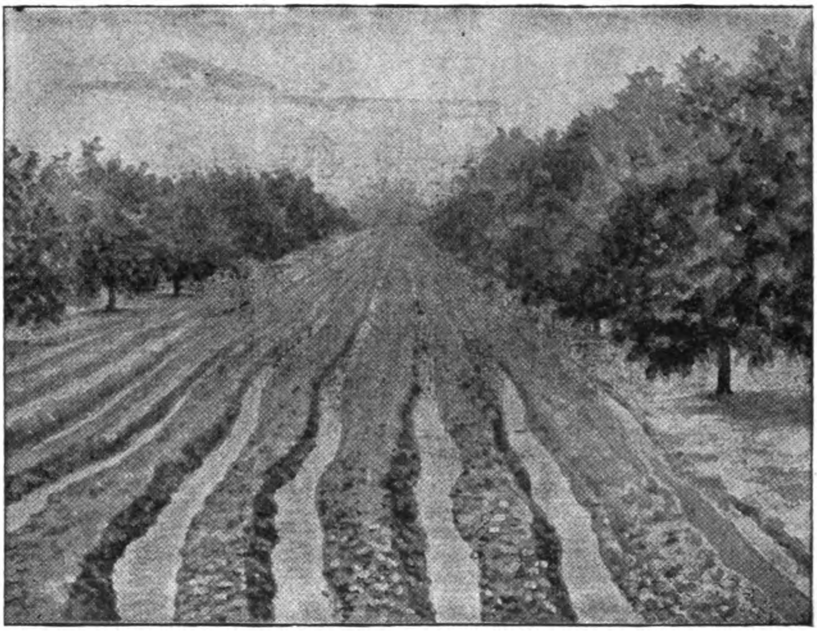


Fig. 452—PARALLEL FURROWS FOR A GROWN ORCHARD

It has long been known that such crops as clover, peas, etc., enrich the land, but the reason for this has only lately been worked out. If the roots of almost any luxuriantly growing legume be examined, numerous gall-like swellings or tubercles, varying in size from the head of a pin to a pea or larger, will be found, as seen in Figs. 453 and 454. These tubercles are not normal products of the plant, but are formed under the influence of micro-organisms. Through the agency of the micro-organisms living in these tubercles the nitrogen of the air is made available for the use of the plant. No one knows just how; but only plants with tubercles are able to assimilate nitrogen from the air, and the amount of nitrogen fixation by any plant has been found roughly proportional to the development of tubercles—the greater the number or size of the tubercles, the greater the amount of nitrogen made available to the plant.

The organisms causing the tubercles have been extensively studied. They are a form of bacteria and have been given the name of *Bacillus radicicola.* They are found in nearly all soils, but are especially abundant wherever legumes have been grown. It now seems probable that there are special forms of bacteria peculiar to each of the different leguminous crops, though the bacteria especially associated with the development of tubercles of one legume may in time accommodate themselves to others. It is a matter of practical importance, therefore, to furnish each soil with a good supply of the bacteria best suited to the growth of the legume it is proposed to cultivate.

This fact was early taken advantage of commercially, and a German company put upon the market a product known as "Nitragin." This purported to be a concentrated pure culture of the bacteria best suited to the growth of the tubercles on each of the more important legumes. Thus there was clover Nitragin, vetch Nitragin, pea Nitragin, etc. It was used generally by soaking the seed to be sown in a water solution of the Nitragin. The reports on the use of this material were sometimes favorable and sometimes unfavorable. But little was ever used in America and now the company manufacturing it has gone out of business.

Another way of inoculating the seed is by soaking them in water in which soil from an old field where the legume has been successfully grown has been stirred. The former is somewhat expensive; the latter method is within the reach of all farmers.

The experiment stations have conducted a number of inoculation experiments. In Alabama hairy vetch seed inoculated with vetch Nitragin yielded 3270 pounds of cured hay per acre and but 564 pounds when ordinary uninoculated seed was used. Another year when the hairy vetch was inoculated with a water extract of infected soil the yield was 2540 pounds, as compared with a yield of but 232 pounds of cured hay per acre when the seed was uninoculated. At the Kansas Station 46 acres of soy beans were effectually inoculated by drilling in with the beans soil in which soy beans had been previously grown. When the inoculated soil was scattered broadcast over the field no tubercles whatever developed on the bean roots. This plan of broadcasting infected soil, though sometimes advised, does not usually give satisfactory results. The soil should be drilled in with the seed. Generally it has not been found necessary to inoculate soils in which the legume has once been grown, and fields once inoculated, either naturally or artificially, remain so for years.

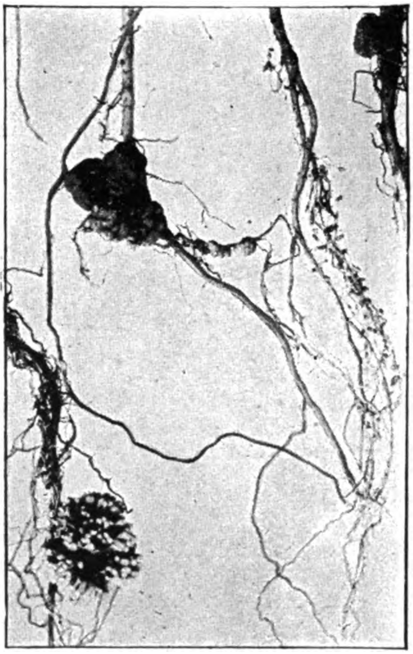


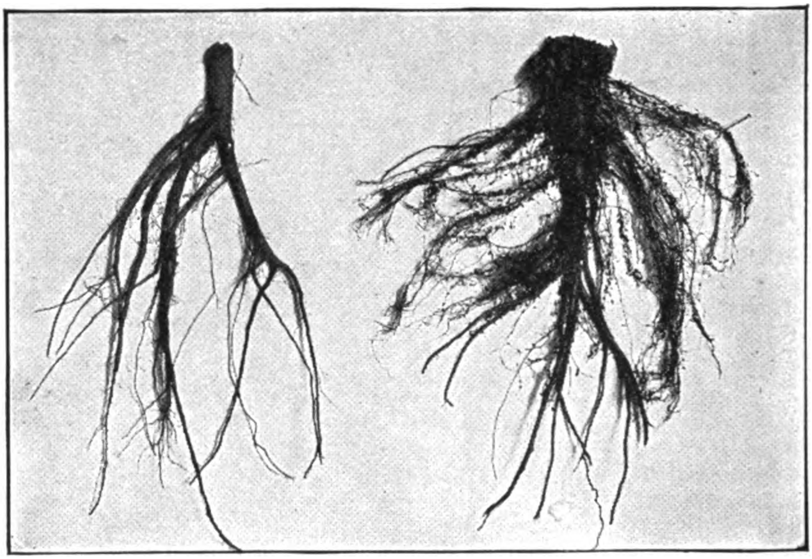
Fig. 453—TUBERCLES ON HAIRY VETCH, RED CLOVER, LUPINE, COWPEA
(N. J. Expt. Stas.)

Very recently the United States Department of Agriculture has announced a new method of growing pure cultures of the bacteria associated with the growth of tubercles on the different legumes. By growing the bacteria in a medium very poorly supplied with nitrogen it has been found possible to increase the nitrogen accumulating efficiency of the bacteria 5 to 10 times beyond the normal. A way has also been found by which these pure cultures of bacteria can be sent out to farmers in dry packages like yeast cakes. These cakes, when dissolved again in water supplied with certain nutrients, multiply very rapidly and to such an extent that a large amount of seed can be inoculated with a comparatively small amount of dry material. For a short period at least the Department proposes to supply the material with directions for use free to farmers who apply for it.

It must be remembered in this connection that not much benefit, if any, will result from inoculating soil in which the tubercles already develop abundantly on the legume which it is proposed to grow. When, however, root tubercles do not develop the seed or the soil should be inoculated. The crop will grow larger and the soil be made richer in nitrogen as a result. Hopkins has recently reported that the bacteria which cause root tubercles on sweet clover may also be used for inoculating alfalfa.

The amount of nitrogen produced in the plant and roots of an acre of hairy vetch at the Alabama Station was 105.5 pounds, crimson clover 143.7 pounds, and rye 26 pounds. The latter is a non-leguminous plant. These figures may be taken as fairly representative of the difference in production of nitrogen of leguminous and non-leguminous plants, and the much greater value of the legume for purposes of green manuring.

Since leguminous crops are capable of utilizing the free nitrogen of the air, this fact becomes of importance in applying fertilizers to such crops. It has been found by repeated experiments that these crops respond promptly to applications of phosphoric acid and potash on inoculated soils, while the addition of nitrogen in any form is usually without benefit, or only very slight benefit, and is invariably done at a loss. When the right kind of bacteria for the production of root tubercles is not in the soil then no tubercles develop, and the legumes are like other plants and require nitrogenous fertilizers for their growth. Another fact has been noticed: If nitrogenous manures are added to soils already supplied with the necessary bacteria, not as many tubercles develop as would otherwise be the case. These facts show that while the legumes require nitrogen, they will take it in the form in which it is most readily obtainable. However, on inoculated soils, practically as heavy crops are grown without the addition of nitrogenous manures as with it. (See also *Green Manuring* and *Rotation of Crops.*)



In untreated soil In inoculated soil

Fig. 454—TUBERCLES ON CLOVER ROOTS

LIME

Lime is of considerable importance in agriculture, being extensively used as a soil amendment. It is found in the ash of all plants and is an essential constituent of all good soils. It exists naturally as limestone, shells, marl, chalk, coral, etc. Quicklime or caustic lime is made by burning limestone or any carbonate of lime in kilns at a very high temperature. Quicklime is more energetic in its action than the carbonates, which are termed mild lime. When quicklime is exposed to the air it gradually slakes and breaks down into a fine powder, when it becomes carbonate of lime or mild lime.

The specific action of lime in promoting plant growth is not well understood. In a mechanical way it acts on the texture of soils. It tends to make heavy clay soils more open, porous and friable and reduces their tendency to puddle. Loose sandy soils are made more compact when treated with lime. In a chemical way acid soils, like many freshly drained muck lands and some uplands, are sweetened by the use of lime and made capable of producing more useful crops like the clovers. Lime also appears to act on the insoluble compounds of potash and phosphoric acid in the soils, making these valuable ingredients more available for the use of plants. It decomposes organic matter in the soil and tends to promote nitrification and to increase the power of the soil to fix and retain such valuable fertilizing materials as ammonia and potash. In meadows weeds like sorrel are lessened and the growth of more valuable forage plants encouraged by the use of lime.

Lime and green manures are considered especially valuable in renovating worn soils. On heavy soils quicklime is of greatest value, and may be applied at the rate of 20 to 40 bushels per acre. It is advisable to begin with a moderate application first and see how it acts. Many soils are already sufficiently supplied with lime. On the other hand, some soils which are high and dry appear, nevertheless, to be sour, and are greatly benefited by lime. On lighter lands which are poor in vegetable matter mild lime or small applications of caustic lime are likely to give the best results.

Lime is best applied slaked. This is best done by pouring water on it and immediately covering it with earth so that the air cannot get to it. In a few days it will be in a finely pulverized condition and most suitable for spreading on the land. Lime is somewhat soluble in water and tends to sink down into the ground. It should therefore not be applied until the ground is partly prepared, when it should be broadcasted and cultivated in the surface soil. On permanent grass lands the lime should be applied in the fall.

Lime should not be mixed with nitrogenous fertilizers, including barnyard manure, poultry manure, etc., as it is likely to injure them by driving off ammonia. It may, however, be advantageous in composting with coarse materials like straw, cornstalks, etc., to hasten decomposition.

Stone lime weighs about 93 pounds per bushel. This will make about 3 bushels of slaked lime, weighing 45 pounds per bushel each. Unslaked oyster shell lime weighs about 60 pounds per bushel, and when slaked 40 pounds per bushel.

Experiments at the Rhode Island Station indicate that timothy, Kentucky blue grass, brome grass, orchard grass and clover are greatly benefited by lime. Other plants benefited in the station experiments were asparagus, onions, chicory, red raspberries, currants, barley, oats, wheat, mangel-wurzels, etc.

The use of lime appears conducive to scab on potatoes and beets, but has proved quite effective in controlling the clubroot of cabbages and turnips and in reducing the soil rot of sweet potatoes. New Jersey experiments also indicate that lime tends to make sweet potatoes round.

MANURE

The care, handling and value of the excrement of farm animals, and the enriching and improvement of the soil by means of green crops, generally known as green manuring, will be considered under this heading. Commercial, chemical or mineral fertilizers are discussed under *Fertilizers*. Such materials as lime, muck, marl, gypsum and salt are noted under their respective names.

Barnyard Manure—It has been calculated that if all the solid and liquid manure from farm animals could be collected and carefully saved it would have an approximate annual value as follows: Horses, $27 per head; cattle, $19; hogs, $12; sheep, $2. Also that during a winter of 7 months a small farm carrying 4 horses, 20 cows, 50 sheep and 10 pigs would produce a quantity of manure having a value of $250. These figures indicate that the manure pile has a greater money value than many farmers assign to it.

When animals were fed liberally and given sufficient bedding to keep them clean at the New York Cornell Station the quantity of manure obtained, and its value per day, estimating nitrogen at 15 cents per pound, phosphoric acid at 6 cents and potash at $4\frac{1}{2}$ cents, were as shown in the following table:

Amount and Value of Manure Produced per 1000 *Pounds Live Weight of Different Animals*:

	Amount per day. Pounds	Value per day. Cents
Sheep	34.1	7.2
Calves	67.8	6.2
Pigs	83.6	16.7
Cows	74.1	8.
Horses	48.8	7.6

The composition of barnyard manure and its character varies greatly with (1) The kind and age of the animal producing it; (2) the quality and quantity of food eaten; (3) character and amount of litter used; (4) method of preserving the manure, and (5) the length of time the manure is kept. On the average a ton of good mixed barnyard manure will contain about 10 pounds of nitrogen, 5 pounds of phosphoric acid and 10 pounds of potash, and will be worth for the plant food it contains about $2.45.

URINE—The urine of animals is much richer in fertilizing ingredients than the solid matter excreted. It is especially rich in nitrogen and potash, but contains little more than a trace of phosphoric acid. For this reason and others the best results will be obtained by using the urine and solid excrement together.

KIND OF MANURE PRODUCED BY DIFFERENT ANIMALS—The manure from growing animals and milch cows is poorer in fertilizing ingredients than that from mature and fattening animals. According to Beal:* full grown animals neither gaining nor losing in weight excrete all the nitrogen, potash and phosphoric acid consumed in the food eaten; growing animals, milch cows, etc., excrete 50 to 75 per cent, and working and fattening animals 90 to 95 per cent. The characteristics of the manure produced by different farm animals also vary greatly. Horse manure is a dry manure of loose texture and quite uniform composition. It decomposes or ferments readily, producing a large amount of heat, and unless well preserved is likely to lose a considerable part of its nitrogen. It is classed as a hot manure and is largely used in the preparation of hotbeds. Sheep manure is quite dry and is commonly the richest of farm produced manures. Like horse manure, it undergoes fermentation easily and is classed as a "hot manure." Pig manure decomposes slowly and is classed as a "cold manure." Cow manure is poorer in fertilizing materials than any of the above, contains considerable water, decomposes slowly and is also classed as a cold manure, Poultry manure is the richest of farm manures, especially in nitrogen and potash, since with this animal the urine and feces are excreted together. Absorbents should be used in its preservation, since it decomposes readily, losing nitrogen. A ton of poultry manure has about double the fertilizing value of a ton of sheep manure.

QUALITY OF MANURE AS AFFECTED BY FOOD—The composition of the food fed greatly influences the quality of the manure produced. Concentrated foods, like meat scrap, cottonseed meal, linseed meal and wheat bran, produce the richest manure; the leguminous plants, like clover, alfalfa and cowpeas, stand next; the cereals third, and root crops last. The manurial value of a ton of a number of feeds is about as follows: Meat scraps, $35; cottonseed meal, $26; linseed meal, $19; gluten meal, $15; wheat bran, $12; crimson clover hay, $9; red clover hay, $7; oats, $6; corn meal, $5.50; turnips, 96 cents. That is to say, these feeds may be worth their full market value as animal feeds and the manure produced from them be worth in addition the above figures. The process of animal digestion adds nothing to the fertilizing value of the feeds fed other than to make them slightly more available for the use of plants. These figures hint at the importance of feeding animals on the farm and carefully husbanding the manure produced.

LITTER IN MANURE—Litter like straw, sawdust, peat moss, leaves, etc., is used in stables primarily to furnish a clean, comfortable bed for animals. It also absorbs the liquid portion of the manure and prevents its loss by drainage, makes the manure easier to handle and tends to check and control its decomposition. Too much bedding should not be used, as it tends to dilute the manure and increase the expense of handling. The best materials for bedding, so far as concerns the composition of the manure, are straw, dead leaves, peat and spent tan bark. The best absorptives are peat moss, peat, sawdust and spent tan. Straw is better than leaves.

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* U. S. Dept. Agr. Farmers' Bul. 21.

FERMENTATION OF MANURE—Manure left in large piles rots and the bulk decreases in weight and size. The rotting is the result of fermentation and decomposition caused by bacteria. Half-rotted manure is usually of greatest manurial value, and well-rotted of least value, while fresh manure is intermediate. One class of bacteria works in that portion of the manure accessible to air. They change the nitrogenous portions of the manure into soluble nitrates, the form in which nitrogen is most readily available to plants. Another class works in the interior of the pile away from the air and is instrumental in breaking up the more complex material of the manure. Considerable heat is generated by the fermenting manure. In the outer portions of the pile the temperature may rise from 120° to 140° F., or even higher. A temperature of about 131° F. is considered most favorable. The temperature on the inside of the pile rarely rises above 95° F.

A too rapid fermentation of the manure tends to a loss of nitrogen and humus. Fermentation is less rapid in moist compact heaps than in loose open heaps. The common and harmful "fire fanging" is caused by a too rapid fermentation in the absence of sufficient moisture, and may be controlled by sprinkling with water.

LEACHING—Experiments have clearly shown that where manure is exposed to the influence of the weather it loses greatly in value through leaching by rain and snow. In loose open piles the loss in fertilizing value may be as much as 50 per cent in 6 months. The manure pile should be kept moist, but should never be placed under the stable eaves. The loss in an open yard will be greatly reduced if the pile is well compacted.

PRESERVATION—Fresh manures that undergo rapid fermentation, like horse and sheep manure, should be mixed as soon as possible with some absorbent like litter to prevent the escape of nitrogen. Gypsum sprinkled on the fresh manure and urine is also a popular preservative, and kainit and acid phosphate are used effectively for the same purpose. The gypsum is not effective unless it becomes moist, and kainit must be used with caution or it will injure the feet of animals. If the "cold" cow and hog manure is intimately mixed with the "hot" horse and sheep manure the heap will be made more moist and the tendency of the latter manures to "fire fang" checked.

Covered barnyards for the preservation of manure are recommended by Roberts and others. The manure should be spread out evenly and well packed down. The stock will do this, in a measure, if they are allowed to run over it. If open yards are used they should be dished toward the center, the bottom puddled with clay and sufficient litter used to absorb the leachings at the bottom.

A common method observed in Europe, and to some extent in this country, for the preservation of manure is by deep stalls. By this method the manure is allowed to accumulate under the animals until hauled to the field. The tramping of the animals keeps the manure well packed and the urine and solid matter are well mixed.

The essentials to be observed in preserving barnyard manure are to keep the pile well packed down so that the air cannot readily penetrate it, to keep it moist by pumping water on it if necessary, but not too wet, and to protect it from sunshine.

USE—Barnyard manure is one of the most valuable of all fertilizers. Not only does it contain all the fertilizing elements required by plants in their growth, but it has a marked beneficial effect on the soil itself, rendering the stored-up food in the soil more available, improving the mechanical condition of the soil, making it warmer and more capable of retaining moisture.

Barnyard manure should be applied when practicable in as fresh a condition as possible. While it is true that the fertilizing constituents of well-rotted manure are more quickly available to plants, "the manure itself is less bulky, easier to distribute, affords a good breeding place for organisms which promote nitrification in the soil, and is less likely to promote rank growth than fresh manure;" nevertheless "fresh manure mixed with the soil readily undergoes fermentation, which not only increases the availability of its own fertilizing constituents, but also assists in rendering soluble the hitherto insoluble constituents of the soil. In fact, even with special precautions to prevent injurious fermentation under the feet of the animals and in the heap, the greatest return is likely to be gotten from manure applied in the fresh condition."*

The form in which manure is used is largely influenced by the soil to which it is applied and the crop grown. The mechanical condition of heavy clay soils is lightened by applications of fresh manure. In such soils the manures are likely to decompose slowly, hence they should be applied considerably in advance of the time the crop is planted. The absorptive powers of clay soils are so great that heavy applications may be made without fear of loss. On light soils rotted manures are likely to be more effective. They make such soils more compact and increase their moisture holding capacity. However, if prompt action is desirable, light soils in favorable seasons are likely to give more favorable results with fresh manures than heavy clay soils. Fresh manures tend to produce a rank, succulent growth of stems and leaves, and are therefore better suited for forage than grain or fruit crops.

APPLYING MANURES—Barnyard manure should be spread out evenly over the ground when it is hauled to the field and not left in small piles, as is a common practice with many farmers. If fields are available and conditions permit, it is advisable to draw the manure and spread it as soon as it is made. In winter, time will nearly always be found between the morning and night "chores" to draw out the manure. This will ease up the rush of work and permit of the more timely planting of important crops when spring opens. On light or sandy soils, however, or on steep lands where losses from drainage are probable, manures should be applied only when they can be soon plowed under. Where manure is scarce or a forcing effect is sought, manure may be applied in drills or trenches, otherwise it should be spread broadcast, care being taken to have it evenly distributed.

The amount of manure to apply will vary with the condition of the soil. Frequent light applications are better than an occasional heavy manuring. From 8 to 12 tons is a good manuring. On truck soils 20 tons are usually applied and sometimes much more.

APPLYING BARNYARD MANURE AND COMMERCIAL FERTILIZERS TOGETHER—Barnyard manure is largely a one-sided manure, being most valuable for the nitrogen it contains, and is generally referred to as a nitrogenous fertilizer. Numerous experiments have shown that the best results are obtained when barnyard manure and commercial fertilizers are used to supplement each other. On very rich truck lands where the soil is already well filled with humus, commercial fertilizers alone are likely to give the best results; but on ordinary soils the two combined will usually prove more effective than either alone.

Barnyard manure is greatly improved in quality when kainit and superphosphates (see *Fertilizers*) are used to help preserve it. This makes it a more balanced fertilizer and better suited for cereals and fruit. Barnyard manure is quite lasting in its effects and need not be applied so often as commercial fertilizers.

Compost consists of mixed and rotted vegetable matter, particularly manure and litter. It is usually made in a convenient level place on puddled clay to prevent drainage. The bottom layer consists of any convenient absorbent like leaves, muck, straw, sod, etc. On this is dumped all the refuse of the farm like manure, weeds, spoiled hay or straw, night soil, sods, leaves and the like. It is desirable to keep it packed down by driving the teams and loads over it and occasionally forking it over. In dry weather the heap should be kept wet down either with water or liquid manure. Compost is of no great importance on the farm, but is very desirable in gardening and greenhouse operations. It is sometimes enriched by composting cotton seed, kainit, ashes, superphosphate, etc., with it. The manure heap should constitute the compost heap of the farm.

For a further and more complete account of the value and methods of handling barnyard manure see U. S. Dept. Agr. Farmers' Bul. 21, by Beal, upon which this account is largely based. See also N. J. Expt. Sta. Bul. 150; Mass. Hatch Sta. Bul. 58.

Green Manuring—By this term is meant the plowing under of green crops grown especially for that purpose. The object of green manuring is to enrich the soil with nitrogen, add humus to it, improve its physical condition and make more available the mineral foods already in the soil. Green crops are often grown between 2 primary crops to prevent the land from lying bare and leaching. Green manuring is of especial value on poor soils that need rejuvenating to produce profitable crops. On good soils it is not an economical practice.

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* Beal; U. S. Dept. Agr. Farmers' Bul. 21.

Two classes of plants are used for green manuring, those that gather nitrogen from the air and in decay add this valuable plant food to the soil, and those that cannot gather atmospheric nitrogen but simply utilize that already in the soil. The first class is by far the most valuable. It is composed of the leguminous plants such as alfalfa, clover, crimson clover, cowpeas, velvet beans, soy beans, beggarweed, serradella, vetches, etc. To the second class belong such crops as buckwheat, rye, mustard, etc. The method by which leguminous plants are able to utilize the free nitrogen of the air in their growth is discussed under *Leguminous Plants.* A good crop of alfalfa, crimson or red clover, cowpeas or velvet beans will contain about 150 pounds of nitrogen, a large proportion of which is obtained from the air. Green manures add no mineral matter to the soil other than that taken from it. They do, however, bring up such foods from the subsoil and store them in the leaves, stems and upper portions of the plant. When the crop is plowed under these materials accumulate in the surface soil, and thus become more available for succeeding crops. Such plants as rye, buckwheat and mustard add absolutely nothing to the soil on which they grow except humus. This, however, is of great value in the improvement of the physical condition of the soil, and for this purpose they may be used until the clovers or some other leguminous plants can be grown. The value of various plants for green manuring is discussed in this work under the plants themselves.

Experiments at a number of stations have shown that it is not an economical practice to plow under the whole green crops. The forage should be gathered and fed to animals and the manure produced returned to the soil. In this way profit is obtained in feeding the animals, and the crops are improved, if anything, for manurial purposes by being put in a form more readily available for the use of growing crops.

A comprehensive treatise on green manuring may be obtained by requesting Farmers' Bul. 16 of the United States Department of Agriculture. See also Ala. Coll. Expt. Sta. Bul. 120 on the cowpea and velvet bean as fertilizers.

MARL

This term as generally used refers to a mixture of carbonate of lime and clay with more or less sand, which readily falls to pieces on exposure to the air. In Michigan, Wisconsin and other Northern States beds of calcareous shell marls occur in the bottoms of old lake beds or under layers of peat. They are composed of more or less decomposed remnants of small shell animals, and often analyze 85 to 90 per cent fine carbonate of lime. These marls contain practically no potash or phosphoric acid. According to the Wisconsin Station they possess considerable value as a fertilizer on soils deficient in lime or as an amendment to clayey, sandy or peaty soils. As a soil amendment at least 40 tons per acre should be applied. For the purpose of adding lime to the soil 1 or 2 tons per acre may be sufficient. Farmers possessing marl beds should apply it to a portion of their land and note the result. It will not usually pay to haul it a great distance, and it is seldom worth more than $4 or $5 per ton.

Other marls of different geologic origin are classified as clay marls, sand marls, blue marl, green marl, red marl, etc. The green shell marls of New Jersey contain only very small amounts of lime, but also some phosphoric acid and potash. The average of many analyses is 2.2 per cent phosphoric acid, 4.7 per cent potash and 2.9 per cent of lime, all in a very slowly available form. Ordinarily those marls richest in lime are of greatest value as fertilizers.

MUCK

The partially decayed vegetable matter found in low wet places, as swamps and bogs. Fresh muck contains about 75 per cent moisture. The weathered muck is valuable as an absorbent in stables and compost heaps, and is about as rich in nitrogen as barnyard manure, but contains only insignificant amounts of potash and phosphoric acid. Fresh muck is not suitable for use as soon as dug, since the nitrogen in it is then in a very inert form, and it also contains considerable amounts of vegetable acids and iron salts. It should be weathered first for 5 or 6 months or composted with lime, ashes or marl. Voorhees states* that where a muck bed exists upon the farm it should first be studied with reference to its possible drainage. If it can be drained it is more likely to prove useful where it lies than to use it as a manure for other portions of the farm, since such soils are particularly valuable when properly managed

* "First Principles of Agriculture."

for growing onions, celery, cabbage, peppermint, etc.

MULCH

This is a term applied to material spread on the ground to prevent the evaporation of soil moisture or for the winter protection of plants. The materials used are dust, straw, leaves, barnyard manure, grass and litter of various sorts. The dust mulch, formed by thorough cultivation of the surface soil 2 to 4 inches deep, is one of the best mulches for preserving soil moisture to the use of growing crops. It is based on the theory that moisture in the soil rises by capillary attraction to the surface and escapes by evaporation unless prevented. It has been found by repeated experiments that a layer of dry dust, such as is formed by cultivation, breaks up the upper end of the tubes and to a great extent prevents evaporation. When the ground becomes packed, as after rains or from long standing without cultivation, the capillary tubes extend to the surface and evaporation becomes very rapid. It is a part of good farming to cultivate lightly after every rain to break the surface crust that forms, and about once every 10 days thereafter. The statement frequently heard that tillage is irrigation is based on this principle of preserving moisture by the aid of a dust mulch. The practice of frequent shallow cultivation often results in normal crops, where by neglect of it they are lost by drouth. In the East cultivation 3 inches deep produces a satisfactory mulch; but in some of the arid regions of the West cultivation 4 to 6 inches deep is necessary to preserve soil moisture. The dust mulch is considered one of the most essential features of modern agriculture.

In Fig. 455 is presented a partial view of the lowland gardens at the Nebraska Agricultural Experiment Station, showing tomatoes, cabbages, onions and beets. The mulched plat is seen in the foreground and the cultivated plat just back of it.

At that station Prof. Emerson made an investigation of the value of a 4-inch straw mulch in the culture of a large number of vegetables. It frequently happens on the farm that the garden is made each spring with enthusiasm, cultivated once or twice and then, as the press of summer work comes on, entirely neglected. Prof. Emerson wanted to see if a good straw mulch applied at the end of the second or third cultivation would not give better results than the usual neglect. As a result of this work he found that mulches are most useful in comparatively dry seasons. Early vegetables that require but 2 or 3 cultivations can be more cheaply grown by cultivation than by mulching. Mulches applied early in the spring before the ground warmed up retarded the growth of the vegetables. Vegetables that normally require cultivation throughout the growing season were

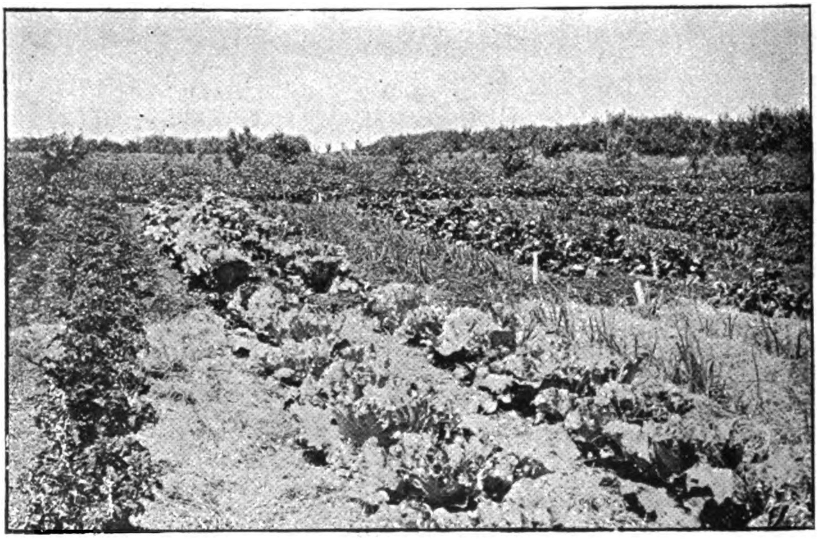


Fig. 455—MULCHED GARDEN AT THE NEBRASKA EXPERIMENT STATION

more cheaply grown by mulching than by cultivation. For most vegetables the mulch should be used to supplement cultivation rather than to displace it.

Specifically the experiments indicated that it is unwise to mulch drilled onions, lettuce or sweet corn. In the first and second cases the stand of plants was usually injured by mulching, and with sweet corn the yields were about the same by both methods of culture, while in wet years mulching decreased the yield decidedly. With transplanted onions and with beets, salsify, carrots, parsnips, peas and melons the results were about the same by either method of culture. Very favorable results were secured in mulching cabbage, tomatoes, beans, cucumbers, potatoes and sweet potatoes. With each of these crops the yields were increased quite decidedly by mulching and the labor required was lessened. Mulched cabbage was also less injured by rot and the same was true of tomatoes. Mulched cucumbers produced perfect fruits during dry periods when the fruits from cultivated plants were small and imperfect. The quality of potatoes was not injured by mulching except in wet places.

Winter mulches of leaves, manure, straw, muck, etc., are of special importance for protecting flowers in herbaceous borders, whether tender or not, and often for small fruits. Data on the use of mulches are reported in Cal. Expt. Sta. Bul. 121; Mich. Expt. Sta. Bul. 35; Mo. Expt. Sta. Bul. 14; N. J. Expt. Sta. Rpt. 1896, p. 398; Tenn. Expt. Sta. Bul. Vol. III, 4; Wis. Expt. Sta. Rpt. 1894.

SALT

The value of salt as a condiment and preservative is well known. It has been used as a fertilizer on some crops with apparently beneficial results. It supplies no essential element of plant food, and its physical action on the soil is not marked. As a rule no increase in yield whatever has been obtained in station experiments by the use of salt, and generally if any increase occurred it was not sufficient to cover the expense of applying.

SOIL

Soil is decomposed rock mixed with vegetable and animal matter. It is composed of many different minerals mixed in varying proportions. The amount of organic matter in the soil also varies. These different combinations of mineral and organic matter result in different kinds of soils; thus we have sandy soils, clay soils, loam soils, muck soils, etc. It is not the purpose of this article to discuss the origin of soils. Books have been written on this subject. We shall note briefly only the characteristics of the more usual soils as they now exist, giving suggestions as to management.

Sandy Soils—By this term is meant soils made up mostly of sand. Such soils are often called light soils, since they are easy to cultivate. A cubic foot of sand, however, actually weighs more than a cubic foot of clay. Pure sand is composed of fine particles of quartz and has no agricultural value whatever. It will not hold water, is nonadhesive and shifting in its nature. Experiments have shown that a fine sand saturated with water and drained retains but about 7 per cent of the amount applied, a clay soil 35 per cent and a forest soil containing humus 42 per cent. Not only is a sandy soil less capable of retaining water than clay or humus soils, but it evaporates water much more rapidly than either. Its power to absorb water from a moist atmosphere is practically nil. Experiments have shown that a dry sandy soil in 1 night absorbed nothing. Loam, on the other hand, absorbed 3.5 per cent, heavy clay 4.1 per cent and garden mold 5.2 per cent of moisture.

Fertilizers applied to sandy soils readily leach through and are lost. On clay or humus soils practically all the ingredients of the fertilizers applied are retained. The capillary power of sand, that is, the power that sand has to draw water up from below, as a wick draws up oil, is less than in clay, loam or humus; hence in times of drouth plants suffer more on sandy land than on heavier soils.

The problem in the improvement of sandy soils, therefore, consists largely in changing their physical condition so that they will retain plant food and moisture. The more clay and humus that can be added to them the greater will become their powers in these respects. Application of quicklime also has a binding effect on sands, making them more compact. The humus content of sandy soils may be increased by growing and turning under green manure crops and by the use of barnyard manures. On very poor soils such good foraging crops as rye, buckwheat and mustard may first be grown and plowed under, lime being used at the same time. It should be the aim to commence growing the more valuable legumes as soon as possible, since these enrich the soil by adding nitrogen to it obtained from the air. (See *Leguminous Plants.*)

Manures should not be applied to sandy soils much in advance of the time crops are planted, since they easily leach out unless the plant roots are present to take up the food as soon as it becomes available. For this reason it is not advisable to apply manures to sandy land in the fall unless a winter cover crop is grown. Nor should sandy lands be fall plowed and left over winter without a cover crop. In wet seasons barnyard manure is very effective on sandy soils; but in dry seasons it may be, especially if very coarse, actually harmful. Half-rotted manure rather than fresh coarse manure is most desirable for sandy lands. The rotations best suited for sandy soils are discussed under *Rotation of Crops.*

Some of the advantages of sandy soils are that they are warm, and therefore best suited for the production of early crops; they are easy to work and may be worked whenever it is not raining.

Clay Soils are retentive of moisture. If worked when too wet they bake, becoming hard and lumpy and difficult to mellow down. They are called cold soils. They are made up of much finer particles than sandy soils and have the power of retaining practically all the fertilizers applied to them. They generally require draining. Often they are so compact as to be extremely difficult to work. In wet weather they are too sticky to work, and after periods of drouth they are frequently so hard that it is difficult to keep a plow in them, and they turn up lumpy.

In the improvement of clay soils drainage, either natural or artificial, is one of the first essentials. (See *Drainage.*) Lime, which has a binding effect on sand, has a loosening effect on clay, and its use tends to make clay soil more mellow and friable and reduces its tendency to puddle. Even a small amount of lime has a marked effect. The addition of humus to clay also makes it more open and porous, and hence easier to work and more productive of crops. To this end coarse manures may be applied and green crops turned under. Since clay soils are generally cold and compact, coarse manures do not rot rapidly in them, and they should therefore be applied considerably in advance of the time when they are needed by growing crops. Barnyard manure applied to clay land in the fall will lose but little of its value over winter by leaching, and, of course, should be applied then. It is advisable when possible to fall plow clay lands, especially in the Northern States, and to leave them rough. This exposes them to the mellowing action of winter freezing and thawing, breaks down the lumps and clods and puts the soil in a more friable condition for spring working.

Clay soils are usually more productive than sandy soils and bear heavier later crops. Manures applied to them are not leached out and they are generally well supplied with potash.

Loam Soils—A soil containing about equal parts clay and sand is called a loam soil. A soil containing 20 to 40 per cent clay and 60 to 80 per cent sand is known as a sandy loam. When the clay predominates it is called a clay loam. Loam soils are the most satisfactory for agricultural purposes, since they are easily worked, productive and retentive of fertilizers. One of the most suitable soils for farming, all things considered, is made up of 50 to 70 per cent of sand, 20 to 30 per cent of clay, 5 to 10 per cent of pulverized limestone and 5 to 10 per cent of humus. The method of handling loam soils is intermediate between that for clay soils and for sandy soils noted above.

Muck Soils—This subject is discussed under *Muck.* Muck soils contain an unusual amount of vegetable matter. They require draining as a first requisite for cultivated crops and weathering for a year or so. Fresh muck soils are likely to be acid, and are therefore benefited by applications of quicklime and ashes. These soils usually contain sufficient nitrogenous matter, but are often deficient in potash and phosphoric acid. For the use of muck as a nitrogenous manure see *Muck.*

Alkali Soils—In numerous large areas throughout the Western States where the annual rainfall is scanty, accumulations of alkali have taken place at various depths in the soil and upon the surface. The most common forms of alkali are sodium chlorid, sulphate of soda or Glauber's salts, Epsom salts and carbonate of soda. These salts are all readily soluble in water and only become visible when occurring in quantities on the surface of the soil, or in the deeper lying strata in a dry condition. On the surface they may form white, glistening incrustations which may be seen for many miles. The most extensive accumulations of alkali usually occur in alkaline lakes. Two forms of alkali are commonly mentioned, the white and the black. Both are white salts, but the name "black alkali" is due to the fact that this salt decomposes vegetable humus, giving it a black color. The name "white alkali" is given to soluble salts which are composed mainly of Glauber's salts or Epsom salts; "black alkali" is a common name of carbonate of soda. The source of alkali is usually considered to be in the decomposition of certain rocks. These salts are naturally found throughout the United States in all soils, but wherever rainfall is plentiful the salts are washed away and do not occur in quantities sufficient to injure growing plants.

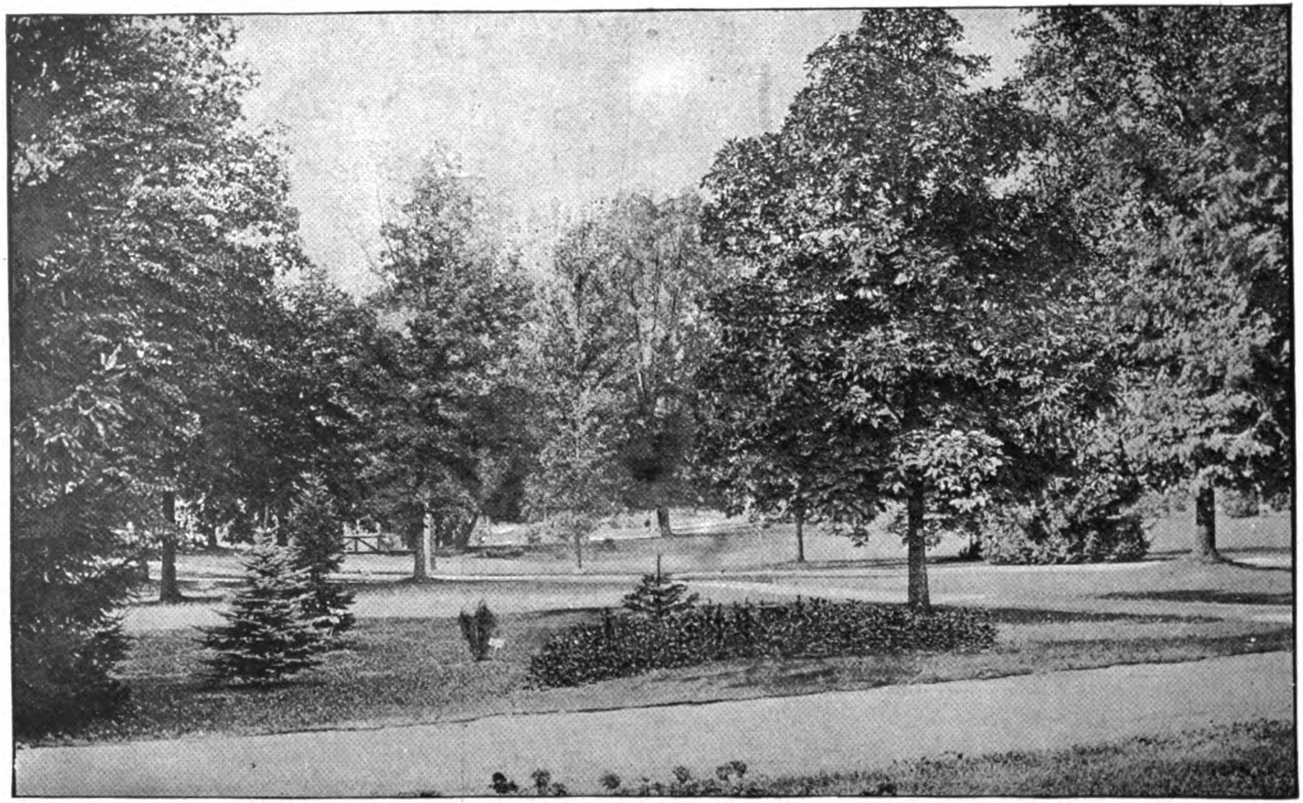
The effect of alkali on plants varies according to the amount which is present upon the surface of the ground and in the first foot or two beneath the surface, as well as other conditions of soil and climate. The effect of black alkali is much more serious upon plants than that of other forms. It exercises a corroding influence wherever it comes in contact with vegetable tissue, and otherwise checks the germination of the seed and development of the plant. Extended experiments with different plants in regions where alkali is abundant have shown that the resisting power of plants varies with regard to alkali. Many plants may be spoken of as intolerant toward alkali, while others are especially capable of growing in the presence of alkali, and are therefore spoken of as tolerant. The plants which are most tolerant are native species which have gradually acquired the power of growing in the presence of exceedingly alkaline soil. These include the so-called salt bushes, salt grasses and weeds of little economic importance. Some of these plants have been introduced from other countries and experimented with for the purpose of determining their possible economic value in reclaiming alkali soil. Among cultivated plants, the most tolerant are alfalfa, sugar beets and sweet clover. It has been found that sugar beets may be grown in strongly alkaline soil. Where chlorids are mixed with the other alkali salts some difficulty is experienced in the crystallization of sugar during manufacture, but for feeding purposes, sugar beets are apparently not badly affected by growing on alkaline soil. Cereals, as a rule, do not do well in the presence of alkali; rye, however, is much more tolerant than wheat and oats, and barley appears to be somewhat resistant to alkali.

Experiments have demonstrated the efficiency of a number of remedies in reclaiming alkali soils. Since the main source of alkali is in the deeper lying strata of the soil, it is apparent that seepage water, when coming to the surface by capillary action, must carry quantities of alkali, which are left upon the surface of the soil by the evaporation of the water. Care should therefore be exercised to prevent excessive seepage. Thorough cultivation of the surface of the soil will make evaporation less rapid and will prevent to some extent the accumulation of alkali at the surface, where it does most harm. Cultivating tolerant plants on alkali ground is also of advantage, especially in the case of deep-rooting plants. Small quantities of the alkaline salts are taken up into the plant substance, and are thus removed when the crop is harvested. The presence of a vegetable covering to the soil prevents the superficial evaporation to a large extent, and water which is required for the growth of deep-rooting plants is taken from a considerable distance beneath the surface. Where the alkali is of the black form, or carbonate of soda, the addition of large quantities of gypsum to the soil changes the carbonate of soda into the less harmful sulphate of soda. This chemical reaction, however, naturally does not take place when the alkali is already of the white form, or sulphate of soda. The use of gypsum, therefore, in such cases is of no value. Lime has a corrective effect upon Epsom salts, and where analyses show this to be the chief alkali salt, liming of the soil is to be practiced.

The remedies thus far mentioned, however, are of a temporary nature and do not remove the alkali from the soil. Wherever plenty of non-alkaline irrigation water is to be had and drainage is possible, the sovereign remedy for alkali consists in flooding the surface abundantly with water, and in under-draining. By this means the alkali salts in the upper strata of the soil are dissolved and carried away in the drainage water. Analyses of such water already made have shown that large quantities are carried away in this manner.

PART VIII

MISCELLANEOUS



VIEW OF CAMPUS, MICHIGAN AGRICULTURAL COLLEGE

FARMER'S CYCLOPEDIA OF AGRICULTURE

MISCELLANEOUS

AGRICULTURAL EXPERIMENT STATIONS

These are State institutions organized for the purpose of conducting agricultural experimental investigations. The first regularly organized experiment station in this country was established at Middletown, Conn., in 1875. Other stations were established soon after in a number of widely separated States, and in 1887 Congress passed a bill, popularly known as the "Hatch Act," appropriating $15,000 annually to each State and Territory for the maintenance of an agricultural experiment station. Since that date stations have been established in every State and Territory, including Alaska, Hawaii and Porto Rico. With but few exceptions, provided for in the Act, the stations must be departments of the land-grant agricultural colleges (see *Agricultural Schools and Colleges*), and their officers are often professors in the college. In several States the United States grant of $15,000 is divided, so that, at the present time, 53 stations in 49 States and Territories are receiving money from the United States Treasury. In each of the States of Connecticut, Massachusetts, New Jersey and New York a separate station is maintained entirely or in part by State funds, and in Louisiana a station for sugar experiments is maintained mainly by funds contributed by sugar planters. In several States branches or sub-stations have been established. If these are included, the number of stations in the United States, including Alaska, Hawaii and Porto Rico, is 57. A perspective view of the experimental plats at the Nebraska Experiment Station is seen in Fig. 457.

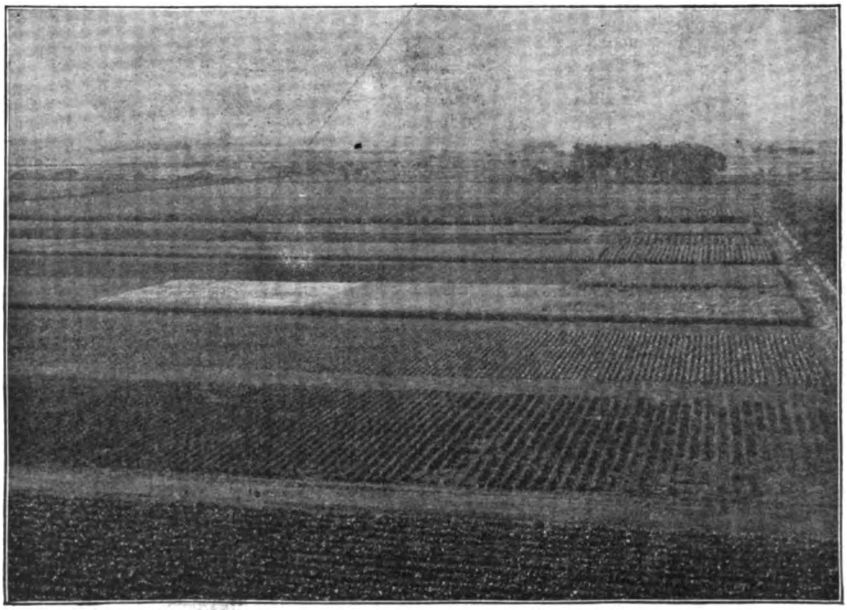


Fig. 457—EXPERIMENTAL PLATS, NEBRASKA EXPERIMENT STATION

Since their organization these stations have conducted a vast amount of research work along nearly all lines of agriculture. The results have been published in the form of popular reports, bulletins, circulars and press notices for agricultural papers, and sent free to a large mailing list of farmers, and to everyone else interested in agriculture who asks for them. In most cases these publications not only give the results of experimental work done at the stations, but include as well information on the practices of our most successful farmers, horticulturists and stockmen. These publications are immensely practical. The experiment stations are becoming more and more popular each year as their purpose and methods of work become known. The most progressive farmers keep in constant touch with them and find them a great help. The work of each station is usually that in which the State, as a whole, is most interested. Most of the bulletins and reports published are better than books on the topics of which they treat, since they generally contain all the latest information in that line and cost nothing.

Notwithstanding the value of these publications and the fact that they are mailed free for the asking, only a small percentage of the farmers of the country avail themselves of them. This arises in many instances from a lack of information concerning them and a knowledge of where to write for them. Below is given an address list of the different stations.

Not only do the stations send out published information, but they give much personal advice in response to letters sent in. This constitutes an important part of the work done, and farmers may feel free to ask the station for any information, at any time, along agricultural lines, and may be reasonably sure of getting a satisfactory reply.

In this volume many references are given under different headings to experiment station bulletins. It is expected that farmers will write for these bulletins whether they are published in their own State or elsewhere, whenever they feel the need of fuller information than the article gives. The stations are represented in the United States Department of Agriculture by the Office of Experiment Stations.

Experiment Station Addresses—In the following list the place in the State where the college is located is given first. This is followed by the name of the station, when there are 2 or more in the State, and then the name of the director. In writing to the stations for bulletins or other information the envelope should be addressed as follows:

Dir. Agrl. Expt. Sta.
Place——————
State——————

This address will insure the letter's being opened as soon as it reaches the station and a prompt reply.

ALABAMA—*Auburn:* College Station; J. F. Duggar. *Uniontown:* Canebrake Station; J. M. Richeson. *Tuskegee,* Tuskegee Station; G. W. Carver.

ALASKA—*Sitka:* C. C. Georgeson.

ARIZONA—*Tucson:* R. H. Forbes.

ARKANSAS—*Fayetteville:* W. G. Vincenheller.

CALIFORNIA—*Berkeley:* E. W. Hilgard.

COLORADO—*Fort Collins:* L. G. Carpenter.

CONNECTICUT—*New Haven:* State Station; F. H. Jenkins. *Storrs:* Storrs Station; L. A. Clinton.

DELAWARE—*Newark:* A. T. Neale.

FLORIDA—*Lake City:* Thos. H. Taliaferro.

GEORGIA—*Experiment:* R. J. Redding.

HAWAII—*Honolulu:* Federal Station; J. G. Smith. *Honolulu:* Sugar Planters' Station; C. F. Eckart.

IDAHO—*Moscow:* H. T. French.

ILLINOIS—*Urbana:* E. Davenport.

INDIANA—*Lafayette:* A. Goss.

IOWA—*Ames:* C. F. Curtiss.

KANSAS—*Manhattan:* J. T. Willard.

KENTUCKY—*Lexington:* M. A. Scovell.

LOUISIANA—*Audubon Park, New Orleans:* Sugar Station. *Baton Rouge:* State Station. *Calhoun:* North Louisiana Station; W. C. Stubbs.

MAINE—*Orono:* C. D. Woods.

MARYLAND—*College Park:* H. J. Patterson.

MASSACHUSETTS—*Amherst:* H. H. Goodell.

MICHIGAN—*Agricultural College:* C. D. Smith.

MINNESOTA—*St. Anthony Park, St. Paul:* W. M. Liggett.

MISSISSIPPI—*Agricultural College:* W. L. Hutchinson.

MISSOURI—*Columbia:* H. J. Waters. *Mountain Grove:* Fruit Station; P. Evans.

MONTANA—*Bozeman:* S. Fortier.

NEBRASKA—*Lincoln:* E. A. Burnett.

NEVADA—*Reno:* J. E. Stubbs.
NEW HAMPSHIRE—*Durham:* W. D. Gibbs.
NEW JERSEY—*New Brunswick:* E. B. Voorhees.
NEW MEXICO—*Mesilla Park:* L. Foster.
NEW YORK—*Geneva:* State Station; W. H. Jordan. *Ithaca:* Cornell University Station; L. H. Bailey.
NORTH CAROLINA—*Raleigh:* B. W. Kilgore.
NORTH DAKOTA—*Agricultural College:* J. H. Worst.
OHIO—*Wooster:* C. E. Thorne.
OKLAHOMA—*Stillwater:* John Fields.
OREGON—*Corvallis:* J. Withycombe.
PENNSYLVANIA—*State College:* H. P. Armsby.
PORTO RICO—*Mayaguez:* F. D. Gardner.
RHODE ISLAND—*Kingston:* H. J. Wheeler.
SOUTH CAROLINA—*Clemson College:* P. H. Mell.
SOUTH DAKOTA—*Brookings:* J. W. Wilson.
TENNESSEE—*Knoxville:* A. M. Soule.
TEXAS—*College Station:* John A. Craig.
UTAH—*Logan:* J. A. Widtsoe.
VERMONT—*Burlington:* J. L. Hills.
VIRGINIA—*Blacksburg:* J. M. McBryde.
WASHINGTON—*Pullman:* E. A. Bryan.
WEST VIRGINIA—*Morgantown:* Jas. H. Stewart.
WISCONSIN—*Madison:* W. A. Henry.
WYOMING—*Laramie:* B. C. Buffum.

AGRICULTURAL OR FARMERS' READING COURSES

These are systematic home courses of reading, which a few agricultural colleges conduct for the benefit of adult farmers, or for farmers' sons and daughters who are unable to attend an agricultural college. While the farmer reads much, his reading is generally of a miscellaneous and desultory character. The idea of the reading courses is to systematize into a few definite lines this general reading. Courses of reading are given on such subjects as "Soils and Crops," "Feeding and Breeding of Live Stock," "Dairying," "Domestic Economy" and other like topics. The college authorities select sets of books for reading which most clearly set forth the principles underlying these subjects, provide for superintending the work, prepare examination questions, etc., and act as a sort of general bureau of information.

"Anyone wishing to take up the work of the reading course has but to apply for membership to the manager of the reading course in his own State, or in another State. Details regarding the courses offered, books required, enrollment fees, etc., will be sent him. Upon subscribing to the rules of the society he is at once admitted as a member and can begin reading without delay. No entrance examinations are required." No cost is attached to the work except for books, the small enrollment fee seldom exceeding $1 for the whole course. Courses are provided for women and technical courses for special students.

These courses of reading are proving very popular and profitable. "A course usually covers about 2 years' reading. A small amount of reading performed regularly each day and extended over a considerable period of time has been found to give better results than a large amount of reading done in a shorter period. As many courses can be taken as desired. Managers of the courses encourage the formation of reading circles in farming communities, since numbers usually add enthusiasm, and the reading and discussion of the topics in common serve to bring out all the points of the lesson and to maintain interest in the subject."

These courses are of comparatively recent origin, the first being established by the Pennsylvania State College in 1892. At the present time courses are being conducted by colleges in seven States. Letters of inquiry addressed to the "Agricultural College," as follows, will reach the manager of the reading course in each case: Connecticut, *Storrs;* Michigan, *Agricultural College;* New Hampshire, *Durham;* New York, *Ithaca;* Pennsylvania, *State College;* South Dakota, *Brookings;* West Virginia, *Morgantown.*

A bulletin on farmers' reading courses, giving in detail the character of the courses at the different institutions and the books used has been published by the United States Department of Agriculture and may be had upon application.

In addition to the above reading courses conducted by agricultural colleges, a number of private concerns now conduct courses in agriculture by correspondence. While a correspondence school can never take the place of a course at an agricultural college, such a systematic course in agriculture as is given by many of these correspondence schools is of immense advantage to the man who must stay on the farm. Some men can plan their own reading. These are the exception. Most men will get much more out of their reading by studying systematically under the direction of trained teachers. Without direction enthusiasm lags and the daily reading is neglected. When there is a definite amount of reading to do each day, with regular examinations and correspondence with instructors, enthusiasm is kept up and more thorough and better work is done. The reading is effective. When, therefore, a young man cannot attend an agricultural college, we strongly commend taking a reading course, either that offered by the agricultural colleges or the course offered by correspondence schools.

AGRICULTURAL SCHOOLS AND COLLEGES

These institutions for agricultural education in the United States may be classified as follows: (1) Institutions in which the sciences related to agriculture are taught; (2) colleges in which these sciences are taught along with the theory and practice of agriculture; (3) schools in which the elements of agriculture and other sciences are taught in connection with the practices of agriculture. In addition to regular courses of from 2 to 4 years' duration, many institutions give short farmers' courses during the winter months. These short courses take up such topics as feeding farm animals, stock judging, butter making, growing small fruits, orchard pruning, greenhouse management, first aid to farm animals, and other like subjects of direct and immediate interest to the man on the farm. Usually there is no cost attached for the instruction other than a small fee for the materials actually used by the student, and the amount required for board. These short courses last from 3 to 8 weeks, or longer, depending on the subjects taken. While of comparatively recent introduction, these short courses are proving of great value to those farmers who cannot take a full college course and who feel the necessity of improving their methods of farming and of keeping up with the progress in agriculture. Many of the agricultural colleges conduct reading courses for the benefit of those farmers who are not able to attend even the short winter courses. The general plan of these courses is described above. (See *Agricultural Reading Courses.*)

At the present time every State and Territory in the United States, except Alaska, possesses an agricultural college. In some instances it is combined with the university of the State, while in a few Southern States (Alabama, Delaware, Florida, Mississippi, North Carolina, South Carolina and Virginia) there are also separate institutions for colored students. The full course in these colleges usually occupies 4 years. Students are admitted at 14 or 15 years of age, if able to pass a satisfactory entrance examination in the elementary branches. Tuition is free for the whole period, and the cost of the course is limited to board and room, books and other incidental expenses of the student. At the Michigan Agricultural College, which is the oldest in the country and one of the best, the actual necessary cost for a student, including board and room, falls within $150 per year.

Both theoretical and practical instruction in all branches of agriculture and related sciences is given in these schools. At the Michigan Agricultural College the course covers the following subjects, and leads to the degree of Bachelor of Science: Algebra, English, military science and drill, botany, agriculture, blacksmithing, carpenter work, drawing, physics, chemistry, geometry, anatomy, physiology, veterinary science, entomology, horticulture, trigonometry, surveying, fungous diseases of plants, rhetoric, agricultural chemistry, forestry, bacteriology, constitutional history, economic zoology, meteorology, engineering, geology, psychology, logic, political economy. Instruction is also given in French and German. There are also short winter courses of 6 weeks in dairy husbandry, livestock husbandry, fruit culture and flower culture, and winter gardening. Provision is also made for post-graduate studies, leading to the degrees of Master of Science, Mechanical Engineer, and Master of Agriculture. The courses in the agricultural colleges of other States are very similar in character.

Combined with the agricultural college is a mechanical department, and in many instances a women's department. The women's course is similar to the agricultural course, except that domestic science, *i. e.*, cooking, sewing, etc., are substituted for farm labor. Instruction is also given in music, drawing and some modern language. In most States the agricultural colleges are strong institutions. The work done is of a high character, both from an educational and practical standpoint, and the schools are well worthy of the support and patronage of every farmer.

ANTS

A number of species of these insects occur in houses, the more important of which are the little red ant, little black ant and pavement ant. None of these are very destructive to household supplies, but become a nuisance on account of getting into sweet food materials. As soon as a discovery of this sort is made by an ant the whole colony seems to learn of it within a short time, and the house may become infested with a large number of ants. As is well known, the colonies of ants contain individuals of different sorts and usually comprise a large number of individuals. Where the nests can be found in lawns or near houses, the ants may be destroyed by pouring boiling water into the nests or saturating them with kerosene, or by making small holes in the nests with a stick, pouring an ounce or two of bisulphid of carbon into each hole and quickly closing the holes. When the nests cannot be found, an efficient method for catching ants in houses consists in placing small sponges moistened with sweetened water where they will be found by ants, and immersing these sponges at intervals in hot water to destroy the ants.

Thorough cultivation of the soil has been found efficacious in destroying ants in some localities. Some species of ants are slightly beneficial from their habits of attacking cotton worms and other injurious insects. When ants are seen running up and down fruit trees and other plants, an examination will usually disclose the presence of plant lice on such plants. As is well known, most plant lice are attended and cared for by ants, and the presence of ants on cultivated plants may thus serve as an indication of infestation of plant lice. Under such circumstances the ants do no harm to the plant except in the way of assisting in the distribution of the plant lice.

BEES

The keeping of bees is an important industry, although by far the greater number of persons engaged in the business have only a few swarms and raise honey for home consumption. In many parts of the country extensive apiaries have been established and managed on a commercial scale, for the purpose of furnishing honey for market. Keeping a few bees in connection with other agricultural pursuits furnishes an agreeable occupation for people who are interested in such work and furnishes a delicacy for table use which is universally held in high esteem.

Aside from the production of honey, which constitutes the main reason in a majority of cases for keeping bees, these insects are of great economic importance in connection with fruit raising. The relationship of insects to the pollination of fruits has been much discussed in scientific journals and in agricultural papers, but the necessity of their assistance in order to secure a full crop of fruit, whether of orchard or berry kind, is perhaps not fully appreciated. Experiments have shown that most fruit trees and bushes are either partially or only slightly pollenized when bees and other insects are prevented from visiting the flowers. Many varieties of fruit trees are self-sterile and require that pollen be carried from other trees or other varieties in order that a good crop of well-formed fruit may be produced. Bees are the most useful of all insects in the fertilization of fruits. The labor incident to maintaining a few colonies about the home is amply repaid in the increased setting of fruit, without considering the value of the honey produced.

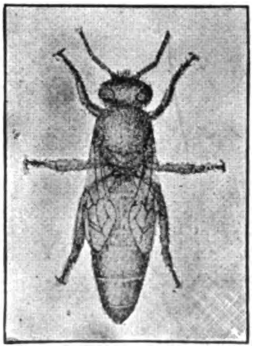


Fig. 458—ITALIAN QUEEN
(After Hunter)

Bees may be successfully kept in any locality where agriculture or horticulture can be pursued with profit. In fact, bees maintain themselves in a wild state in many situations where agriculture is as yet impossible on account of the lack of cleared and arable ground. Besides ordinary agricultural regions in country districts, bees may be kept in cities, especially favorable situations being found on the house roofs. From such locations they can easily reach garden plants, sweet clover, white clover and other honey-producing plants.

Bee Plants—It has often been supposed that in order to keep bees profitably, or even successfully, it is necessary to plant special crops for the purpose of producing honey. Experiments along this line have shown that the cultivation of special honey plants is neither profitable nor desirable. In all agricultural and horticultural regions a sufficient number of honey-producing plants are cultivated for other purposes, and bees, besides assisting in fertilizing such plants, can obtain enough honey for their own use during winter, and also a considerable quantity which may be removed for consumption in the family. Among the more valuable bee plants mention may be made of clovers, white, alsike, crimson, and the 2 species of sweet clover, fruit blossoms of all varieties, alfalfa, willow, esparcet, linden or basswood, rape, buckwheat, chestnut, cotton and locust trees. Besides these cultivated plants and shade trees, a very large number of wild herbs and trees are visited by bees for the purpose of obtaining honey or pollen. In the South the redbud, alder, soft maple, June-berry, orange, black gum tree, white sage, sourwood and saw palmetto are important honey-producing plants. In the Northeastern part of the country willows, wild crabapple, yellow locust, tulip tree, linden, knot-weeds, buckwheat, grape, willow herb and goldenrods furnish large quantities of bee food. In the Middle and Western States a number of the trees and other plants already mentioned serve as a source of honey, but special mention should also be made of white sage, Rocky Mountain bee plant and buck-brush or waxberry. Bees readily adapt themselves to the flora of the particular locality in which they are raised, and quickly choose the plants which furnish most pollen and honey for their use.

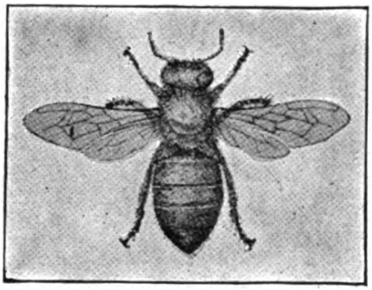


Fig. 459—ITALIAN WORKER
(After Hunter)

Varieties of Bees—A few experiments have been made in introducing the giant East Indian honeybee (*Apis dorsata*) into this country, but experiments have not been carried far enough to permit definite conclusions as to the value of this species. The common honeybee (*Apis mellifica*) is represented in this country by several varieties or races—Cyprians, Italians (Fig. 458 and Fig. 459), Carniolans (Fig. 460 and Fig. 461), and German bees. The common brown or German bee was the first variety imported into this country and is distributed from the Atlantic to the Pacific. The Cyprians are good honey collectors and work persistently when the honey secretion becomes scanty. They are easily kept through the winter and defend their hives with great energy. On account of filling the cells completely before capping, the honey has a transparent appearance which interferes with its successful marketing, and the bees are easily aroused and led to attack attendants. Italians cap the honey so that the comb appears white, and much less skill is required in subduing and handling them. They are far gentler than the Cyprians. The Carniolans are of a gray color and are perhaps the gentlest of all races. Since they have shown their good qualities in resisting the climatic changes of winter and in gathering large stores of honey under adverse circumstances, they are gradually becoming more and more popular.

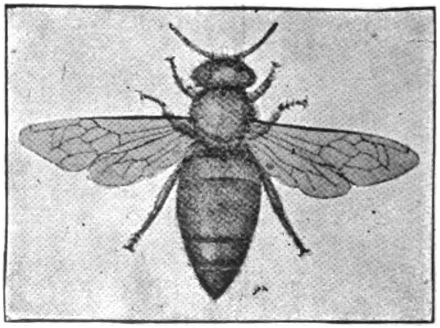


Fig. 460—CARNIOLAN QUEEN
(After Hunter)

In an average locality for honey collection, a vigorous colony should produce about 20 pounds of comb honey, besides what is required for winter keeping of the bees. This amount will be considerably increased when colonies are favorably located near large areas of 2 or more of the most important honey plants. Large stores of honey should not be expected in all seasons, and the amount which is gathered by bees varies greatly from season to season, depending on drouths, earliness or lateness of the season, and other less thoroughly understood conditions, which determine the honey flow.

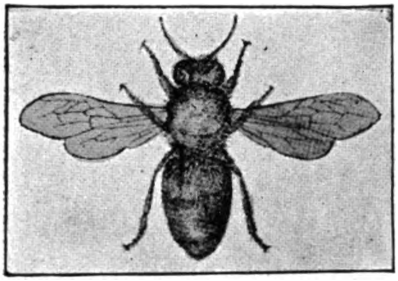


Fig. 461—CARNIOLAN WORKER
(After Hunter)

The management of bees may be readily learned by anyone who desires to manipulate them. The Carniolans are perhaps the best choice for amateurs, since, as already indicated, they are the gentlest race. After some experience with bees, other races may be preferred in certain localities, according to experience in each locality.

Hives—The Langstroth hive (Fig. 462) is most generally adopted. This hive is not patented and may be obtained from all manufacturers of bee supplies. These hives are cheap and it is perhaps best to buy them of regular dealers, since the proportions will be more accurate and the fitting of parts is more perfect than would be the case in homemade apparatus. Where it is desired to obtain comb honey, hives should be used which permit insertion into the brood apartment of a number of frames, up to 10. The Langstroth hive readily admits of expansion and contraction, as occasion requires. It should be covered with a tight-fitting, rain-proof roof in winter. A number of hives may be surrounded with a frame structure, leaving a few inches of space between the hives and the outside structure, which may be filled with straw, excelsior or other substances. All bee keepers should be provided with 1 or more bee smokers, which are sold at moderate prices by all manufacturers of bee supplies. Smoke is almost universally used for the purpose of quelling or stupefying bees, when it is necessary to open the hive for the purpose of removing honey or for inspection. The beginner will find it desirable to use a veil to protect the face and gloves for the protection of the hands. Old and experienced apiarists often find these accessories unnecessary.

Swarming—Ordinarily, when a colony of bees puts forth a swarm, the bees fly about for a short space of time and gather in a clump on a tree, bush or other convenient object near the apiary. The process of transferring the swarm to a new hive will be determined largely by the circumstances of each case. When the swarm collects upon a small branch of a tree, the branch may be moved gently and the whole mass of bees carried and deposited in a hive, or they may be shaken off into a hive by 1 vigorous blow. If the practice of clipping the queen's wings is followed, the queen will of course fall to the ground as soon as the swarm issues, and may be secured in a cage. The bees, after flying about for a short time, return. If in the meantime an empty hive is placed in the position where the parent colony previously was, the bees will enter the new hive and the queen may be allowed to go in with them.

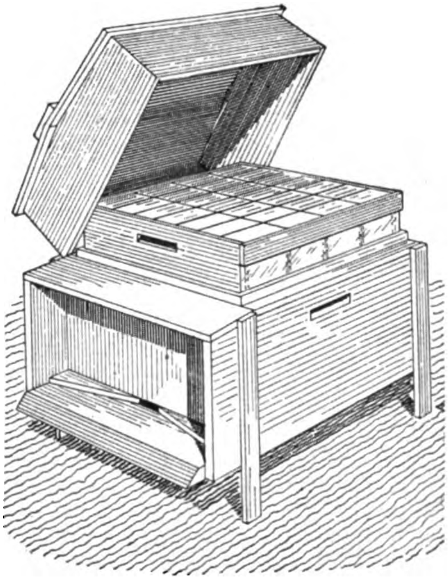


Fig. 462—LANGSTROTH HIVE
(U. S. Dept. Agr.)

It is frequently desirable to prevent swarming entirely or to prevent the issuance of more than 1 swarm during the season. It is evident that the more energy the bees give to the production of young bees, the less extensive will be the honey production. One of the most commonly practiced preventive measures is to give abundant room for the storage of honey. This should be arranged for early in the season. Free ventilation should be accorded the bees, and when hot weather appears, the hives may be shaded, in order to prevent the development of a too high temperature inside the hives. Hives may be opened once or twice weekly and all the queen cells destroyed. The various problems connected with apiculture have been investigated at the Colorado, Michigan, New York State, Rhode Island, Vermont and Nebraska Stations. Queen traps have been so constructed that the queen on returning to the hive is captured. The use of such traps and clipping the wings have been generally recommended by the stations.

Wintering Bees—Wintering bees in greenhouses is not to be recommended. It appears that bees are useless for pollinating fruits in winter and are not content with the limited quarters, but spend a great portion of the time trying to escape from the houses. When bees are moved into cellars the apartments should not be damp and the temperature should be maintained between 44° and 48° F. If the temperature of the cellar is allowed to rise too high, the bees become active, a much greater loss of bees occurs, together with a much greater consumption of store. When bees were kept at a uniform and not too high temperature, the average consumption of honey for the colony during the winter was 15½ pounds, in one series of experiments. In the South bees are wintered on summer stands in the open air. This method is also successful in the North, with proper precautions; but usually they are placed in cellars, or a secondary box-like structure is built around them for further protection. When the winter season is entered upon, it is essential that the colony should have a good queen, an average sized cluster of healthy bees, and a sufficient quantity of food. In the South from 15 to 20 pounds is considered sufficient for outdoor wintering, while a similar quantity is sufficient for wintering in cellars in the North and from 30 to 40 for outside wintering. In outdoor wintering, cold and dampness are the great obstacles to be overcome. A good cluster of bees can resist a very low temperature if thoroughly dry. The chief problem of wintering is to retain the warmth generated by the bees and at the same time prevent a too great accumulation of moisture in the hives. In cold climates colonies may be packed with dry chaff or similar substance in such a way that the moisture is absorbed without allowing a free draft through the hive.

Apiaries should be situated so that there are no serious obstacles near at hand to interfere with the flight of the bees to and from the hives. A place may be easily selected which is not needed for other purposes and will not interfere with other agricultural operations. In some localities it may be well to choose a protected side of a building, where the colonies will not feel the force of the wind in winter and where they may be sheltered from the direct rays of the sun during the hottest part of the summer.

Feeding Bees—In many cases it will be found desirable to feed bees during the winter season for the purpose of bringing the colony out in the spring in a more vigorous condition. In some experiments where extracted honey was fed back after the honey season was over, it was found that this was done with a profit of nearly 6 per cent. Other experiments along the same line have been unsatisfactory, and in some parts of the country stimulative spring feeding is positively injurious. In feeding sugar syrup to bees, it is perhaps the best practice to feed a considerable quantity rapidly. Sugar syrup is probably a more economical food for bees than honey.

Where comb-honey is being produced for the market, a great amount of work is put upon the bees in the manufacture of necessary wax. Wax is made out of honey and from materials which are collected by the bees, and a large number of bees are necessarily kept from doing the regular work of collecting while engaged in the manufacture of wax. It has been found advisable, therefore, to furnish wax in some form to bees for their use in building comb. Wax thus furnished is usually in the form of a foundation, with or without cell walls. The bees use the wax in the artificial foundation to extend the cell walls and comb midrib. If the heavy foundations are used, they are somewhat thinned out by the bees in constructing comb upon them, but such foundations are not thinned in any case to the lightness of natural comb. The cell walls in a natural worker comb are thinner than the walls built upon artificial foundations, with the exception of those which are constructed upon extra thin superfoundations. It is a mistake to use artificial foundations with artificial deep cells, unless their walls can be rendered as thin as those of the natural cell walls. Heavy foundations result in combs which are heavier than the natural combs, and the increased weight is due both to thickened midribs and thickened cell walls, but more especially to the latter. The natural wax secretion of bees is not lessened any more by furnishing them with heavy foundations than by the use of light foundations. In order to secure the most regular sections of honey, firmly attached all round the section, it is well to use a long narrow piece of foundation as a starter, placed across the top of the section, or a rectangular starter extending about half way down the section. (Fig. 463.) By using a long piece of foundation as a starter, gradually tapering to a point, with the broad base attached to the upper edge of the section, bees have a tendency to form worker comb throughout. It is advisable to use wooden or tin separators between the rows of sections, since the presence of these structures renders the sections more regular and tends to prevent the attachment of one section to another and the consequent breakage of the cells by separating the sections.

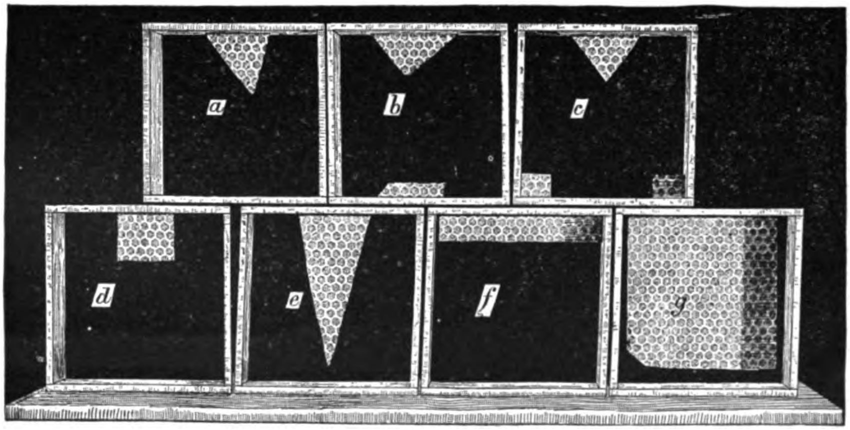


Fig. 463—METHODS OF USING STARTERS

A number of substitutes for pollen have been experimented with, these substitutes being placed on flat boards in the vicinity of the apiary. The order of preference by the bees so far as observations have been made, is as follows: Ground whole kernels of oats, corn, wheat, fine wheat bran.

The appearance and condition of honey when put in market has a direct effect upon the price. Different markets vary in the form of package required, but the section boxes and shipping crates shown in Fig. 464 are coming more and more in general use.

Increasing Length of Tongue—Experiments are being conducted for the purpose of determining whether the tongues of bees can be increased in length to such an extent that they will be enabled to extract honey from plants in which the honey is at present inaccessible to them. The results thus far obtained are somewhat encouraging, a slight gain in length having been noted from a single direct cross. It is at present uncertain how great an advantage would be derived from lengthening of the tongues.

Diseases—Among the diseases of bees, mention should be made of DIARRHEA, which is often brought about during the winter season. It is probably caused by sour, fermented, or thin honey. Bees located near cider mills often contract this trouble from feeding too extensively on apple pomace. Intense cold or dampness and unfavorable climatic conditions may bring about this disease. The best remedy is warmth in the hive and proper conditions for an outside flight without liability to chill.

The most important disease of bees is Foul Brood. This disease is highly contagious and is due to the action of *Bacillus alvei.* The first symptoms are lack of energy, dead larvae in the cells, which show sunken caps and which later become perforated. A brown stringy putrid mass is found in the diseased cells, and a disagreeable odor is noted in infected colonies. A section of comb infested with foul brood is shown in Fig. 465. Several methods of treatment for this disease have been recommended. According to the stamping out method, all infected bees, combs and frames are destroyed and the hives thoroughly disinfected. This method is recommended by many authors on apiculture. A second method consists in removing the infected combs and allowing the bees to fast during a few days, when they are placed upon clean new comb and fed on a syrup containing honey, nutmeg, saffron, or other substances. Several modifications of this latter method have been recommended by different writers. Numerous experiments have been conducted in the treatment of foul brood with chemicals. Different methods have been employed involving a thorough disinfection of the hive and the bees by means of external applications of antiseptic substances, or light feeding of bees with syrups containing carbolic acid, creolin, salicylic acid, or other germicides. Feeding methods have proved fairly effective when proper precautions are taken, but they are usually too elaborate and expensive to be undertaken by amateur bee raisers. When a colony of bees is found to be affected with foul brood, great precautions should be taken to prevent the spread to other swarms. If only a few bees are found diseased, they should be burned immediately. If the disease is not present in a virulent form and there are no other neighboring apiaries which are exposed to the contagion, a cure may be reasonably attempted. Combs may be removed and the bees confined in an empty box, where they are allowed to fast for some days. Hives may be disinfected with carbolic acid. Bees may be removed a second time and a second disinfection carried out. It may be advisable to feed syrup containing 1 part of carbolic acid or phenol to 400 or 500 parts of syrup.

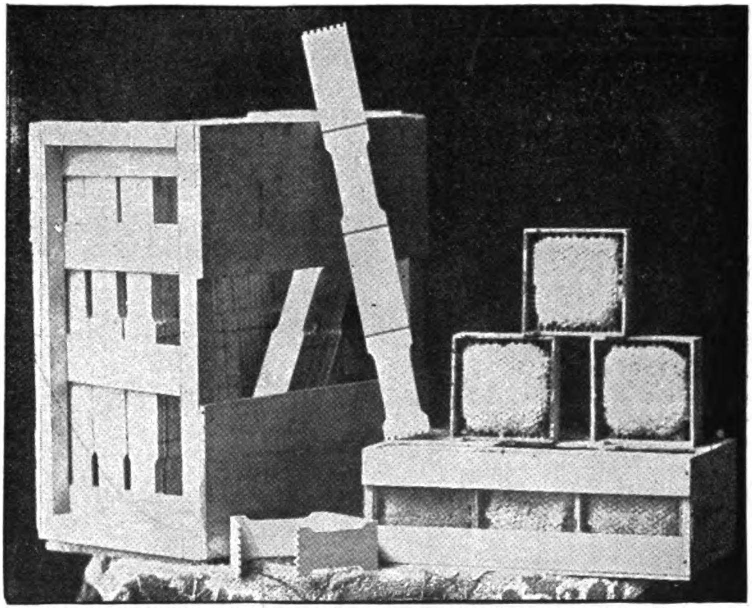


Fig. 464—SECTION BOXES AND SHIPPING CRATES
(After Hunter)

The Bee-Moth (*Galleria mellonella*) eats its way through the combs, especially in the brood apartments, and is often very destructive to weak colonies. The larvae of this insect protect themselves from the bees by lining their galleries with a coating of silk. The adult moths may often be seen in the corners of the hives. They are of a dull ash color, variously streaked. When seen flying about the entrances to hives, they are seeking opportunity to enter and lay their eggs. The best remedy against this insect is to keep the combs under the protection of bees. Combs should be so hung as to leave space between them in a large box where they may be subjected to fumigation with sulphur fumes. The larvae of the bee-moth will thus be destroyed. So-called moth-trap attachments to hives are practically useless.

Robber flies, dragon flies, some species of ants and wasps, a few spiders, and a number of birds, destroy the bees, but seldom become of economic importance.

Literature—The beginner in bee culture may profitably consult Farmers' Bul. 59; "The Bee Keeper's Guide," by A. J. Cook; "The A B C of Bee Culture," by A. I. Root, and "Quinby's New Bee Keeping," by L. C. Root.

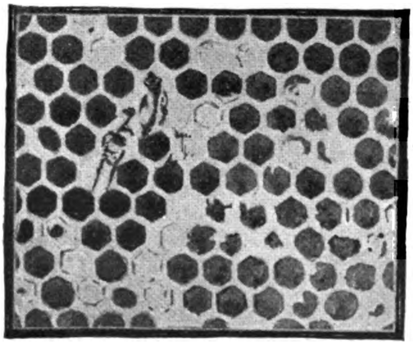


Fig. 465—SECTION OF COMB INFESTED WITH FOUL BROOD

BULLETINS

The agricultural experiment stations publish the results of their experimental work in small pamphlets called bulletins. Many of these bulletins are popular discussions on the growing of some particular farm or garden crop; the management of fertilizers and manures; feeding and care of stock, etc., and are very valuable. The bulletins of each station are sent free to the citizens of the State in which the station is located upon application, and also to those outside the State who may apply for them so long as the supply is available. For addresses of the stations see *Agricultural Experiment Stations.*

The following is a list of Farmers' Bulletins published by the United States Department of Agriculture and now available for free distribution. As will be seen they cover a wide range of subjects. Copies will be sent to any address on application to senators, representatives and delegates in congress, or to the Secretary of Agriculture, Washington, D. C. The missing numbers have been discontinued, being superseded by later bulletins.

16. Leguminous Plants. Pp. 24.
22. The Feeding of Farm Animals. Pp. 32.
24. Hog Cholera and Swine Plague. Pp. 16.
25. Peanuts: Culture and Uses. Pp. 24.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 32.
29. Souring and Other Changes in Milk. Pp. 23.
30. Grape Diseases on the Pacific Coast. Pp. 15.
31. Alfalfa, or Lucern. Pp. 24.
32. Silos and Silage. Pp. 32.
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34. Meats: Composition and Cooking. Pp. 29.
35. Potato Culture. Pp. 24.
36. Cotton Seed and Its Products. Pp. 16.
37. Kafir Corn: Culture and Uses. Pp. 12.
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40. Farm Drainage. Pp. 24.
42. Facts About Milk. Pp. 29.
43. Sewage Disposal on the Farm. Pp. 20.
44. Commercial Fertilizers. Pp. 24.
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46. Irrigation in Humid Climates. Pp. 27.
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48. The Manuring of Cotton. Pp. 16.
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50. Sorghum as a Forage Crop. Pp. 20.
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53. How to Grow Mushrooms. Pp. 20.
54. Some Common Birds. Pp. 40.
55. The Dairy Herd. Pp. 24.
56. *Experiment Station Work—I. Pp. 31.
57. Butter Making on the Farm. Pp. 16.
58. The Soy Bean as a Forage Crop. Pp. 24.
59. Bee Keeping. Pp. 32.
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61. Asparagus Culture. Pp. 40.
62. Marketing Farm Produce. Pp. 28.
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64. Ducks and Geese. Pp. 48.
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69. Experiment Station Work—III. Pp. 32.
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71. Essentials in Beef Production. Pp. 24.
72. Cattle Ranges of the Southwest. Pp. 32.
73. Experiment Station Work—IV. Pp. 32.
74. Milk as Food. Pp. 39.
75. The Grain Smuts. Pp. 20.
76. Tomato Growing. Pp. 30.
77. The Liming of Soils. Pp. 19.
78. Experiment Station Work—V. Pp. 32.
79. Experiment Station Work—VI. Pp. 28.
80. The Peach Twig-borer. Pp. 16.
81. Corn Culture in the South. Pp. 24.
82. The Culture of Tobacco. Pp. 24.
83. Tobacco Soils. Pp. 23.
84. Experiment Station Work—VII. Pp. 32.
85. Fish as Food. Pp. 30.
86. Thirty Poisonous Plants. Pp. 32.
87. Experiment Station Work—VIII. Pp. 32.
88. Alkali Lands. Pp. 23.
89. Cowpeas. Pp. 16.
91. Potato Diseases and Treatment. Pp. 12.
92. Experiment Station Work—IX. Pp. 30.

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* **Bulletins entitled Experiment Station Work are made up of a number of short farm articles based on the results of station experiments.**

93. Sugar as Food. Pp. 27.
94. The Vegetable Garden. Pp. 24.
95. Good Roads for Farmers. Pp. 47.
96. Raising Sheep for Mutton. Pp. 48.
97. Experiment Station Work—X. Pp. 32.
98. Suggestions to Southern Farmers. Pp. 48.
99. Insect Enemies of Shade Trees. Pp. 30.
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101. Millets. Pp. 28.
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104. Notes on Frost. Pp. 24.
105. Experiment Station Work—XII. Pp. 32.
106. Breeds of Dairy Cattle. Pp. 48.
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117. Sheep, Hogs and Horses in the Northwest. Pp. 28.
118. Grape Growing in the South. Pp. 32.
119. Experiment Station Work—XV. Pp. 31.
120. Insects Affecting Tobacco. Pp. 32.
121. Beans, Peas and Other Legumes as Food. Pp. 32.
122. Experiment Station Work—XVI. Pp. 32.
123. Red Clover Seed: Information for Purchasers. Pp. 11.
124. Experiment Station Work—XVII. Pp. 32.
125. Protection of Food Products from Injurious Temperatures. Pp. 26.
126. Practical Suggestions for Farm Buildings. Pp. 48.
127. Important Insecticides. Pp. 42.
128. Eggs and Their Uses as Food. Pp. 32.
129. Sweet Potatoes. Pp. 40.
130. The Mexican Cotton Boll Weevil. Pp. 30.
131. Household Test for Detection of Oleomargarine and Renovated Butter. Pp. 11.
132. Insect Enemies of Growing Wheat. Pp. 40.
133. Experiment Station Work—XVIII. Pp. 32.
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135. Sorghum Sirup Manufacture. Pp. 40.
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143. The Conformation of Beef and Dairy Cattle. Pp. 44.
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146. Insecticides and Fungicides. Pp. 16.
147. Winter Forage Crops for the South. Pp. 36.
148. Celery Culture. Pp. 32.
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150. Clearing New Land.
151. Dairying in the South. Pp. 48.
152. Scabies in Cattle. Pp. 24.
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158. How to Build Small Irrigation Ditches. Pp. 28.
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183. Meat on the Farm—Butchering, Curing, etc.
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185. Beautifying the Home Grounds. Pp. 24.
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187. Drainage of Farm Lands. Pp. 40.
188. Weeds Used in Medicine. Pp. 48.
189. Information Concerning the Mexican Cotton Boll Weevil. Pp. 31.
190. Experiment Station Work—XXIV.
191. The Cotton Bollworm. Pp. 24.
192. Barnyard Manure.
193. Experiment Station Work—XXV.
194. Alfalfa Seed.
195. Annual Flowering Plants.

CAT

The earliest records of antiquity contain references to the domestication of cats and the esteem in which they were held. Despite the fact, however, that they have been domesticated for such a long time, comparatively few distinct breeds have been developed. A few color types have been developed and attempts have been made to breed certain races as pets, such as the Maltese, Persian and Angora breeds (Fig. 466), but as a rule the color patterns of cats are not constant. The failure to produce distinct, pure breeds of cats is apparently due in large part to the promiscuous crossing and consequent mixture of blood. No such differences in the size and general formation of the animal have been produced by domestication as have occurred among dogs and most other domesticated animals. There is no apparent tendency toward the production of a race of cats which possess any characters fitting them for special use of any sort. The raising of cats is consequently carried on largely for the purpose of producing pets. Their economic relationship to agriculture is not of great importance. Healthy, vigorous cats may serve to prevent the undue multiplication of mice and rats around dwellings and farm buildings. Some cats also manifest decided tendencies toward more extensive hunting expeditions, and destroy large numbers of birds, field mice, rabbits and gophers. The effect of the destruction of these animals depends in large part upon the habits of the animals which are destroyed.

Cats are subject to distemper (see under *Dog*), and to tuberculosis, anthrax, and other infectious diseases which are contracted by eating the meat of animals dead of these diseases. For treatment of cat flea see under *Dog*.

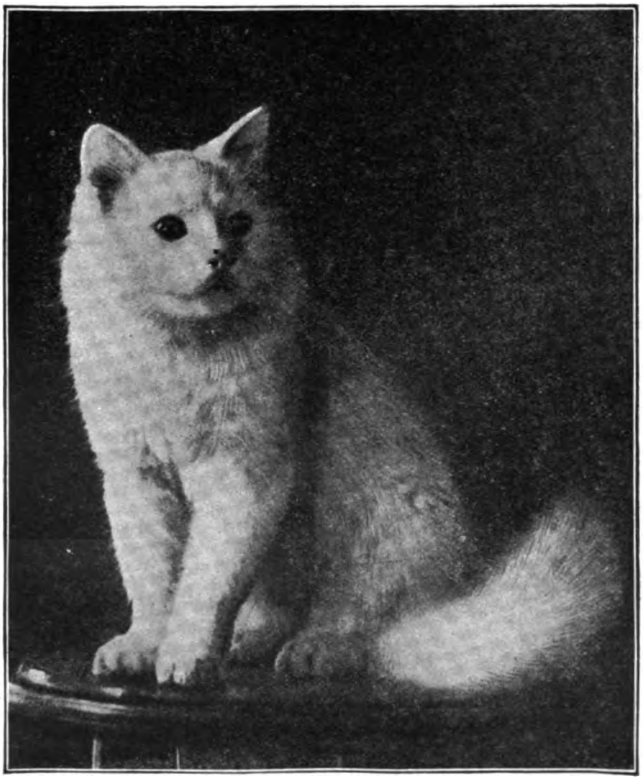

Fig. 466—ANGORA CAT
(Boericke & Tafel Cat Book)

DOG

Dogs have been domesticated and used by man for various purposes since the earliest records obtainable of man's doings. The breeds of dogs are perhaps as numerous and show as many fundamental differences as in any other species of domesticated animal. All travelers have observed certain distinctive peculiarities in the common breeds of dogs in different countries. In general there is a greater or less resemblance between the domesticated dogs of a country and the wild species of the dog family. For example, the Esquimaux dog resembles the large gray wolf, and the Indian dog possesses certain resemblances to the coyote. It is impossible to determine whether the various breeds have been developed from a single wild species, or from several. It is probable, however, that a number of wild species became domesticated in different countries and that the present great variation among dogs is due to the differences in the original species from which they developed and to various crossings which have subsequently taken place. Domesticated dogs cross freely with wolves, jackals and other wild breeds of the dog family, and the hybrids thus produced are fertile to some extent. The common Indian dogs of the Western States show great resemblance to the coyote in their form, color and voice.

The marked tendency to variation and power of adaptation to changed conditions have made it possible for dogs to be utilized by man for a great variety of purposes. No details of the uses to which dogs are put can be mentioned in this brief account, but it is sufficient to call attention to the development of very different types of hunting dogs used in the pursuit of various game birds and mammals, to dogs used as draft animals and beasts of burden, and to sheep and drovers' dogs which are so indispensable in the management of sheep and cattle, one of the most valuable kinds of which is the Scotch Collie, a fine specimen of which is seen in Fig. 467.

While dogs may be of great use and value upon the farm, they may also be a source of nuisance and trouble, and it hardly seems advisable to keep any but healthy, vigorous animals, which show a tendency to be useful for some purpose, or at least manifest no bad habits. Dogs may be instrumental in carrying various diseases, such as glanders, anthrax, tuberculosis, etc. Their well-known habits of eating carrion make it possible for them to spread these diseases by feeding upon the carcasses of dead animals. All such carcasses should be destroyed by burning or burying. In many States the sheep-killing tendencies of mongrel dogs have greatly checked the sheep industry and have caused enormous destruction of these animals. It is obvious that dogs which are not provided with a home and properly cared for may be harmful rather than beneficial.

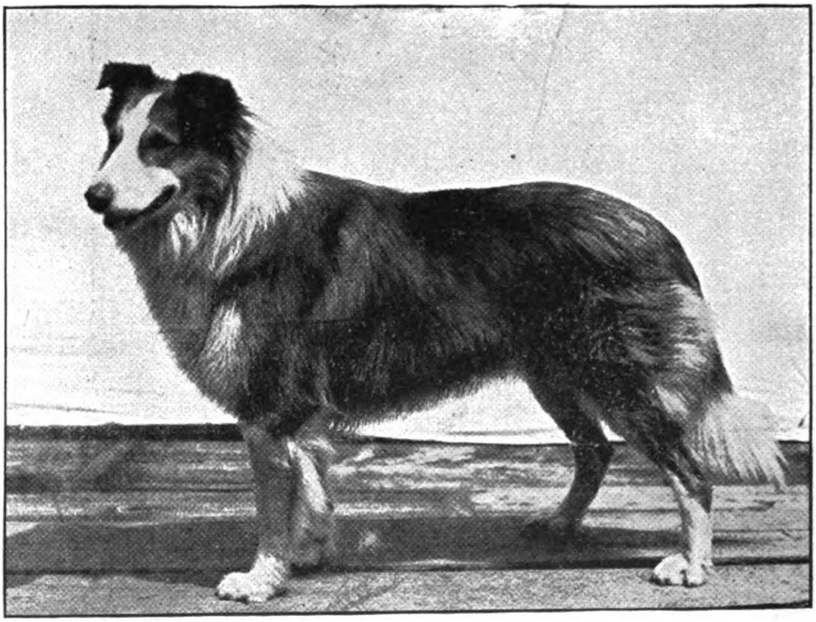

Fig. 467—SCOTCH COLLIE
(Breeder's Gazette)

Diseases: MEDICINES—For an account of the medicines and of the doses mentioned under the diseases below see *Veterinary Medicines.*

DISTEMPER is a malignant, contagious disease due to the action of a bacillus, and affects dogs, cats, and related carnivorous animals. Animals suffering from this disease lose their appetite and show a considerable elevation of temperature. There is usually a discharge from the eyes, which is at first watery but later becomes thick and yellow in color. A catarrhal condition is present in the lining of the nose and extends later to the bronchial tubes and lungs. Ulcers may appear on the mucous membrane of the nose. In most cases a persistent cough is noted and the breath has a disagreeable odor. Occasionally, affected animals become excited and have spasms, but usually they are much stupefied. The disease is a very serious one and from 50 to 60 per cent of the cases die. If an animal is valuable enough to warrant treatment, the eyes may be washed with a 5 per cent solution of borax or a 1 per cent solution of carbolic acid. For controlling the temperature phenacetin or acetanilid may be given in 2-gram doses every 2 hours. As a tonic, 5 drops each of dilute hydrochloric acid and tincture of nux vomica may be given in water 3 times a day.

RABIES or HYDROPHOBIA is an acute disease of the nervous system which is transmitted by means of the bites of mad dogs or other animals, and is due to a virus. The disease attacks dogs, cattle, horses and other domestic animals, as well as man. The extent of the disease is not so serious as is often believed from exaggerated accounts. The symptoms of rabies usually appear in from 3 to 5 weeks after the animal is bitten. In man the disease appears after about 72 days. The symptoms of rabies vary greatly in different species of animals which are affected and may often closely resemble those of tetanus or lockjaw. In cases of the latter disease, however, there is no evidence of viciousness. Animals affected with rabies show violent attacks of the disease from time to time, during which they bite at man or other animals and transmit the disease in this manner. In dogs, the disease manifests itself especially as an uneasiness which compels the animals to run about violently for periods of considerable length, while these acute attacks are followed by periods of stupefaction. Affected horses may bite or kick at the slightest noise or moving object. The ears are held erect and the eyes stare. Between the acute attacks the animals may eat and drink. The treatment for rabies in man consists in successive inoculations of weakened virus, according to the Pasteur method. This treatment may be obtained at the various Pasteur institutes in the different States. A similar treatment of domestic animals would probably be equally effective, but is too expensive in most cases, and such animals should be immediately destroyed, in order to prevent their spreading the disease by biting other animals.

DOGS DISTRIBUTE SHEEP TAPEWORMS—Considerable importance attaches to the problem of the relation of the dog to the sheep industry. On large sheep ranges dogs are almost universally used to help the herder in the management of sheep. On this account it is unfortunate that the dog should also be so common and important an agent in the distribution of the most injurious tapeworms of sheep. According to some authorities, the common tapeworms which occur in the intestines and bile ducts of sheep are the cause of great losses in these animals, and since these tapeworms live during one of their stages in dogs it is easy to see how dogs may be the means of spreading the tapeworm eggs over the grass upon which the sheep feed. Sheep dogs or other dogs which are allowed in sheep pastures should be treated periodically for tapeworms. Perhaps the best remedy for this purpose is areca nut given in doses of 2 grains to each pound of the dog's weight. The dose will, therefore, vary according to the size of the dog. This treatment should then be followed after 2 hours by a tablespoonful of castor oil. The presence of tapeworms in dogs usually causes no striking symptoms, and therefore the extent of infestation by these worms is not fully appreciated. Coyotes and wolves are also instrumental in distributing tapeworm eggs in the same manner as dogs.

FLEAS are a common, well-known pest of dogs and cats, and also infest houses to considerable extent. The larvae of these insects require dark moist places for their development, such as are furnished by cracks in the floor or heavy carpets which remain down during the whole year. In houses with smooth floors covered with rugs and frequently swept, fleas never become a great nuisance, either in the household or upon domestic animals. If dogs and cats are allowed about the house, they should be provided with a rug to sleep on, and this rug should be frequently shaken or otherwise treated for the destruction of fleas. A badly infested dog may be washed with soapsuds or thoroughly dusted with pyrethrum powder.

MANGE or ITCH is a disease which is common to dogs and various domestic animals, as well as man. The disease is due to the presence of a mite of flattened and circular form which burrows in the skin, causing an itching sensation and the development of pustules or scabs. The treatment for this disease should be the same as for sheep scab. When sheep are being dipped for scab, the dogs should be thrown into the vat along with the sheep. (See under *Sheep*.)

EXPERIMENT STATION RECORD

This is a monthly publication issued by the Office of Experiment Stations of the United States Department of Agriculture. It contains summarized accounts of the work each year of all the State and Territorial Experiment Stations and of the several divisions of the United States Department of Agriculture. Abstracts are also given of experiments in agriculture in all current agricultural periodicals and of foreign works on agriculture and the related sciences. Leading original articles on various agricultural topics are frequently contributed to the Record by specialists or by the editors of the Record, and suggestions made regarding methods and lines of investigations which the stations may usefully follow. Each number contains about 100 pages, except the twelfth, which is the index. It costs 10 cents a number, or $1.00 per year, and may be obtained by addressing the Superintendent of Documents, Union Building, Washington, D. C. The work is semi-technical in nature and especially useful to scientific workers in agriculture and up-to-date farmers, containing as it does a very complete reference to all the important

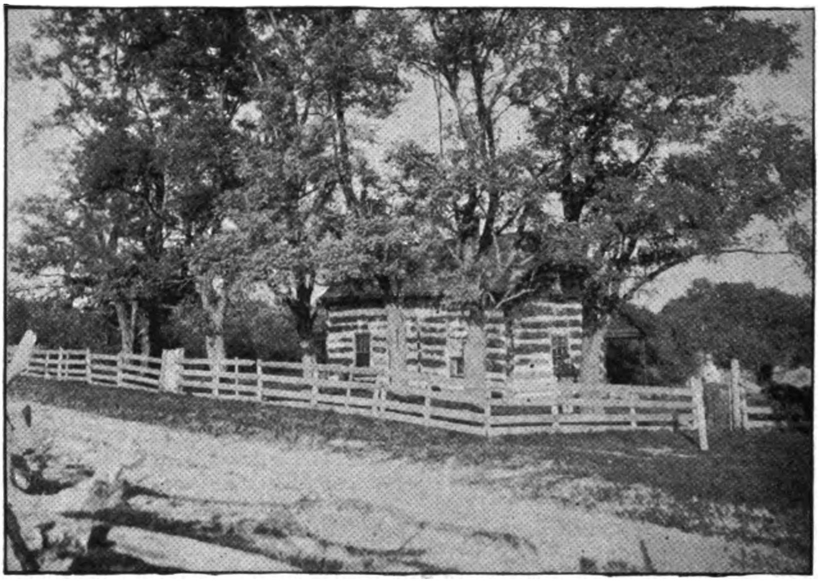

Fig. 468—THE OLD HOME WITH TREES
(Wyo. Expt. Sta.)

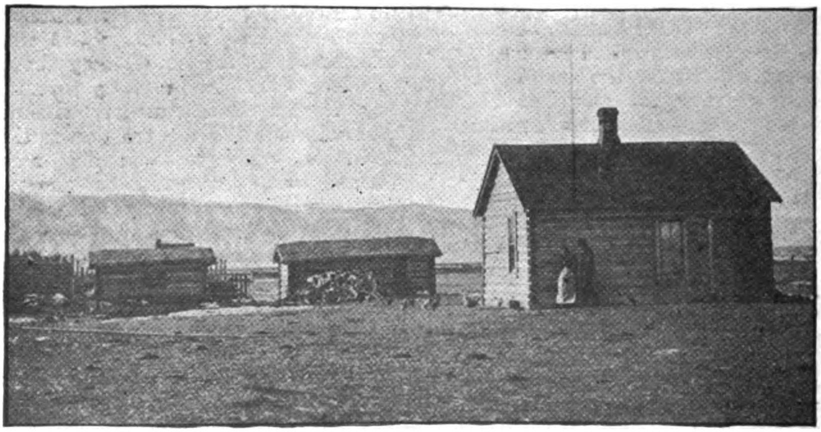

Fig. 469—TREELESSNESS—THE NEW HOME
(Wyo. Expt. Sta.)

work along agricultural lines in this and other countries. Fifteen volumes have been published.

FORESTRY

Even in the early periods of the development of the United States much interest was manifested in preserving the forests against wanton destruction. It was not realized, however, that the apparently inexhaustible forests could be so readily brought to the verge of extermination. Lumber and pulp-paper companies carried on operations of increasing proportions without regard to the protection of timber which was not desired for immediate use and without regard for the future of the forests. In addition to wasteful methods of lumbering, forest fires from various causes have annually destroyed large areas of standing timber. As the rapid destruction of forests became more apparent, large areas of timber were set aside as reserves by the National and State governments, and this movement is still in progress, with the result that at present more than 62,000,000 acres of timber land is included in National and State forest reserves and parks. A study of the value and influence of forests on agricultural and industrial interests has brought to light the intimate relation between forests and water supply throughout the country. The most striking illustrations of this fact are to be had in the Western States, where irrigation is necessary for successful agriculture. The presence of forests in such situations is an extremely important factor in preventing the rapid melting of snow and superficial run off of water. The results of deforestation are readily observed in floods of greater or less severity, and in scarcity of water at times when it is most required. The preservation of big game in Western States in their present numbers also requires the existence of large areas of timbered land as nearly as possibly in its natural conditions. But of more importance than anything else is the influence of trees on the appearance, comfort and actual value of the farmhouse, as will be seen by a comparison of Figs. 468 and 469.

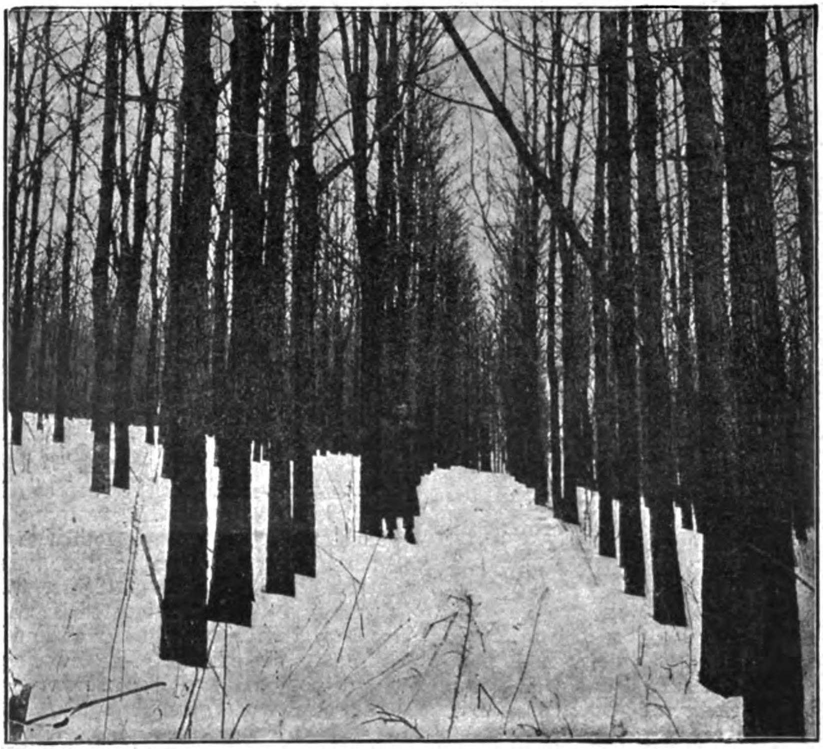

Fig. 470—HARDY CATALPAS TWENTY YEARS OLD
(U. S. Dept. Agr.)

The Bureau of Forestry of the Department of Agriculture is engaged in the study of problems relating to practical forestry. In many parts of the country studies are being made of the rate of growth of various trees, the conditions which are most suitable to reproduction of the forests, and the value of various species of timber for different purposes. A striking illustration of rapid timber growth is seen in Fig. 470. In addition to all matters involved in general forest investigation, the Bureau undertakes to render practical assistance to farmers and other private owners of timberland, in managing their timbered areas in such a way as to secure the greatest possible production of lumber or wood with the least injury to the timbered areas. Private owners of important tracts of timber may secure a contract with the Bureau of Forestry according to which experts are sent from the Bureau for the purpose of studying the special conditions and recommending a plan of management for any particular timbered area.

The administration of national forest reserves is at present in charge of the Division of Forestry of the Department of Interior. This Division has immediate charge of all superintendents, supervisors, fire wardens and rangers in the various forest reserves, and administers the law regarding permits for sawing lumber in the reserves and for grazing cattle or sheep.

Publications on various phases of forestry, and plans of co-operation between the Bureau of Forestry and farmers, may be had by addressing a request to the Department of Agriculture, Washington, D. C.

FROGS

The rather uniformly good prices which are obtained for frogs in market have led a number of persons to attempt the business of frog raising for profit. Newspaper accounts occasionally appear describing in somewhat exaggerated terms the profits to be derived from this business. Where farmers own land enclosing or bordering upon marshes which cannot economically be drained and used for other better purposes, some returns may be obtained for time expended in encouraging the breeding of bullfrogs in such locations. Frogs may be brought in from other localities and colonized in the marsh where it is planned to raise them, and in this way their numbers may be so increased that they may be profitably captured for market. The returns from this business, however, have never been large and the enterprise can hardly be recommended to the average farmer, especially since, as a rule, time expended in giving attention to frogs could be more profitably used in other directions.

GROUND SQUIRRELS

Ground squirrels, or more properly spermophiles, are also often called gophers, although this term should be reserved for an entirely different family of mammals, the pocket gophers. Five or more species of ground squirrels are found in the valley of the Mississippi and its tributaries. They extend westward to the Pacific Coast and eastward as far as Michigan and Indiana. Ground squirrels are everywhere recognized as important enemies of agriculture, on account of their habits of feeding on cultivated pasture grasses and grains. The ground squirrels are especially injurious in fields of grain, which they destroy in great quantities. In cultivated fields they are also harmful on account of the large mounds which they throw up in digging their burrows.

The most important natural enemies of ground squirrels are badgers, hawks, owls, foxes and coyotes. The burrowing owl often destroys the young of prairie dogs. These animals have similar feeding habits to the ground squirrel. The badger is everywhere an important enemy of the ground squirrel. They are slow of movement on the surface of the ground, but burrow with great vigor and persistency. In many localities the ground squirrels have been completely exterminated by the badgers, which latter have finally migrated from the locality, leaving the old burrows of both animals uninhabited. The offering of bounties by State governments for the destruction of ground squirrels has usually proved unsatisfactory. These pests may be successfully combated by the use of irrigation water, where this can be had in large quantities, or by carbon bisulphid. The last named method consists in pouring about an ounce of carbon bisulphid into the burrow and closing the burrow immediately thereafter. The fluid may be poured into the burrow directly from a bottle, or perhaps preferably a wad of cotton or other substance may be saturated and rolled into the hole. Poisoning with strychnin is less effective and is unsatisfactory, on account of the danger of poisoning other animals. Traps and fumigation with sulphur have been used with success in many localities. The meat of young squirrels is tender and of a delicate flavor and the animals are often hunted as game. (Div. of Biological Survey Bul. 4.)

GYPSY MOTH (*Porthetria dispar*)

This moth was brought to this country from Europe in 1869 and has since become very injurious to shade trees, fruit trees, and other plants in the vicinity of Boston. Large sums of money have been expended by the Legislature of Massachusetts in an attempt to exterminate the pest. A gypsy moth commission was organized and employed a large force of laborers for a number of years, with promising results in some localities. The Legislature finally refused to make appropriations for work of the season of 1901, believing that the insect was not destined to spread so rapidly as had been believed, and that it was impossible to exterminate it. The female moth measures about 2 inches across the wings, is of a yellowish-white color, with black markings on the outer edge of the wings. The male is considerably smaller and of a brown color with similar black markings. The female does not fly. The eggs are deposited in masses on the bark of trees or in any protected situation. The caterpillars, when full grown, are about 2½ inches long and sparsely covered with hairs, which arise from red or blue warts on the body. There is an indistinct black line along the back. The gypsy moth feeds upon almost any green plant and is at times exceedingly destructive. The remedies which have been used with most success in combating this insect include collection of egg masses, destruction of caterpillars under burlap bands placed about the trunks of trees and spraying with arsenate of lead or other arsenical poisons.

LOCUSTS

The term locust is frequently applied to the cicada or 17-year locust, but should more properly be reserved for the group of insects commonly known as grasshoppers. These insects are too familiar to require any description for identification. The eggs are laid in masses and covered with a glue-like substance. They are deposited in the ground or in dead wood. There is only 1 generation per year and the winter is usually passed in the egg state. All species of locusts are injurious to some extent but several of them multiply in such numbers as to cause great destruction of cultivated plants. The more destructive species are usually arranged in 2 classes according to their habits, migratory and nonmigratory. Among the most noted species of locusts mention should be made of the Rocky Mountain locust, the lesser migratory, red legged, 2-striped, differential, American, pellucid winged, long winged, pale winged and devastating locusts. The Rocky Mountain locust is generally considered the most destructive of all these species and has occurred at various times in such numbers through certain Western States as to cause a veritable plague. This species occurs permanently in the Rocky Mountain region and extends out into the great plains. Beyond the permanently infested region the insect occurs at times in great numbers and in recent years has caused extensive damage. This area includes Minnesota, Iowa, Missouri, Kansas, Arkansas, Indian Territory and Texas. The eggs are laid in any kind of soil but preferably in bare sandy places on dry, rather compact ground. Meadows and pastures where the grass is closely eaten off are favorite places for egg laying. In localities where vegetation is scarce the eggs are frequently laid around the base of shrubs. The egg mass is usually placed about 1 inch below the surface. Young locusts, when migrating, are most active during the warm hours of the day and move in armies in the same general direction. The young travel at the rate of about 10 feet per minute. The adult winged locusts when migrating fly at different rates, according to the conditions of the locality, perhaps averaging about 20 miles a day. Extended flights are not observed until a few days after the locusts have acquired complete wings.

Much injury to cultivated crops which is commonly attributed to the Rocky Mountain locust is done by the various species of nonmigratory locusts which are always found in greater or less numbers in most localities. Occasionally the nonmigratory forms may multiply to such an extent as to be exceedingly injurious. The habits of various species, except with regard to the matter of migration, are so similar that they need not be described for the individual species.

There are many remedies which have been devised for the destruction of these insects. One good remedy consists in scattering poisoned bait, made of bran 400 pounds, middlings 15 pounds, syrup 2 gallons, arsenic 20 pounds, the whole being moistened with water. Horse manure poisoned with Paris green is equally good. Swarms of young locusts may be checked by spraying them with kerosene emulsion or by spraying the vegetation in front of them with Paris green or other arsenical poisons. Where the young locusts are present in great numbers, perhaps the best means for combating them is some form of a hopperdozer. This apparatus usually consists of a strip of sheet iron 8 or 10 feet long, turned up about an inch in front and about a foot behind, so as to form a shallow vessel in which water may be kept, covered with a film of kerosene oil. The apparatus is mounted on wheels or runners and propelled by man or horses. The young grasshoppers spring into the air as the hopperdozer passes along and fall into the kerosene, where they are destroyed. The young locusts usually collect at night under grass or other substances which may serve as protection. This habit may be taken advantage of in destroying them. If dry straw be scattered over infested fields in early spring and burned at night or early in the morning, the young locusts which have collected under it will be destroyed. Deep fall plowing will cover the eggs so that a large number of the young locusts will be unable to reach the surface of the ground in the spring. In South America, South Africa and Australia, good results have been obtained in fighting locusts by the use of a fungous disease. This disease has been imported into the United States and used with some success. The use of various tarred barriers, ditches supplemented with holes into which the young locusts fall, and irrigation ditches, has been recommended as means of checking the advance of an army of young locusts. These methods are very effective in localities where they can be conveniently applied. (U. S. Entomological Commission Rpts. 1, 2, 3; Div. of Entomology Buls. 25, 27, 28.)

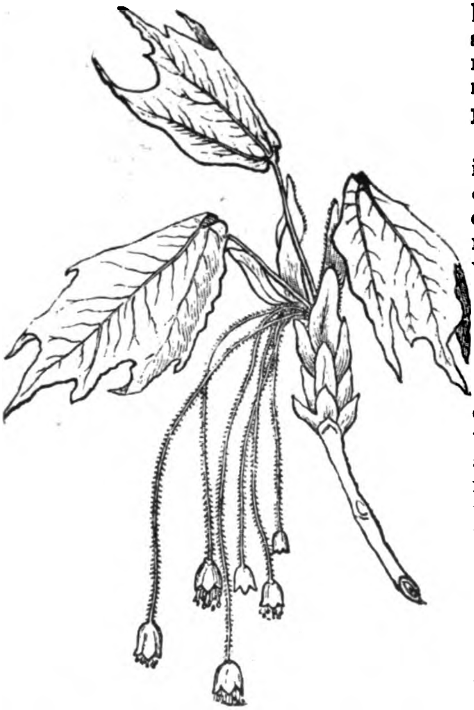

Fig. 471—FLOWERS OF THE SUGAR MAPLE

MAPLE (*Acer* spp.)

There are more than 25 species, including many more varieties, of maples now cultivated in this country for street and ornamental planting. Most of them are natives and a number are forest trees valuable for lumber, firewood and the production of sugar. The maple is one of the most desirable of deciduous shade trees and in the North probably more maples are used in street planting than any other tree. They thrive on nearly all soils. One of the most valuable of the maples for street planting and for sugar is the hard, rock, or sugar maple (*A. saccharum*). Where this tree thrives as in the North it is advisable to use it in setting out about the farm, since it yields a considerable amount of sugar as well as affording shade and ornamentation. It is from the standpoint of sugar that the maple will be considered in this article. The flowers of the sugar maple are seen in Fig. 471, leaf and seed in Fig. 472.

Maple Sugar—Maple sugar is made by boiling down the sap of the maple tree until it grains. The sap flows most freely and the best sugar is made in the early spring before the buds start. Freezing nights and warm sunshiny days make ideal sugar weather. The sap is obtained by boring into the tree and inserting some kind of close fitting tube, either wooden or tin. Experiments at the New Hampshire Station show that practically twice the amount of sap is obtained when the trees are tapped to a depth of 4 or 5 inches as when tapped but 2 to 2½ inches, as is the usual practice. If a ⅜-inch bit be used in making the holes practically no harm to the tree is done. In general more sap will be obtained if the trees are tapped on the south side than on the north side. Sugar makers frequently tap their trees so that 2 spouts run into the same pail. In such cases the holes in the tree should be at least 6 inches apart; otherwise as much sap will be obtained from 1 hole. The flow of sap is longer from the inner wood of the trees than from the outer wood. More sap will also be obtained if the trees are retapped toward the end of the sugar season. Trees 10 inches or more in diameter are usually tapped on 2 sides.

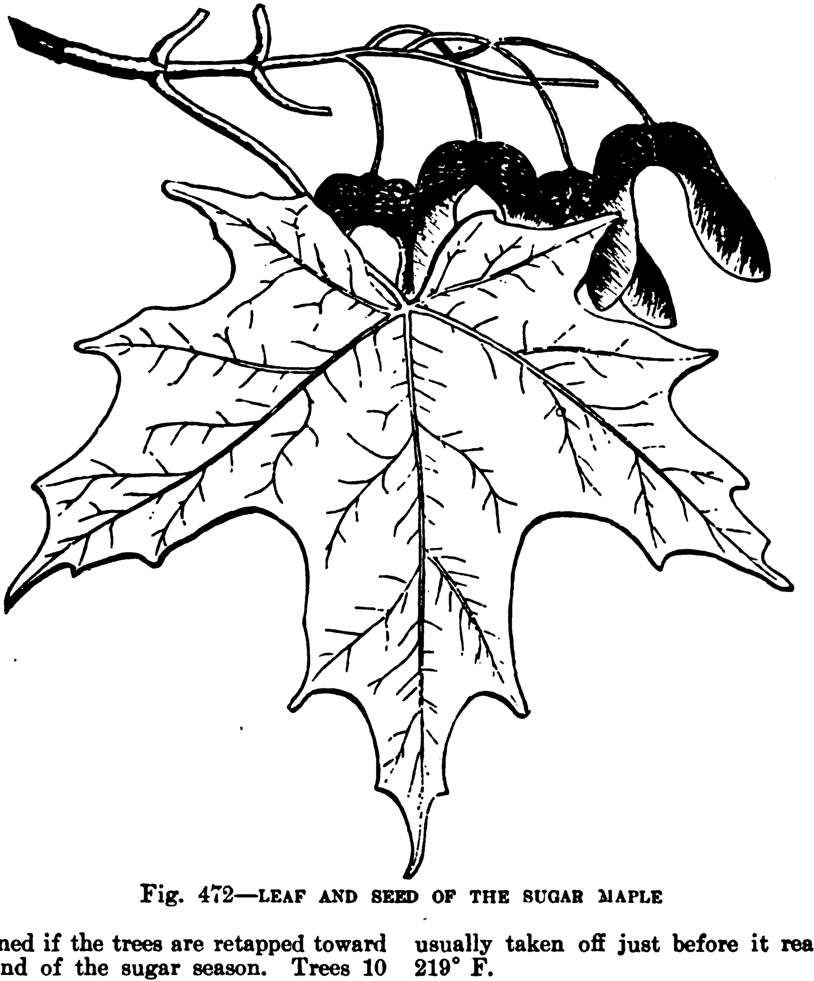

Fig. 472—LEAF AND SEED OF THE SUGAR MAPLE

In boiling down maple sap into syrup and sugar an accurate thermometer is one of the best helps the sugar maker can have. Common tin thermometers are seldom accurate, and only the better glass thermometers should be used. When sap first boils its temperature is about 213° F.; as it increases in density by boiling down the temperature rises. This fact is taken advantage of to make syrup and sugar of uniform character each time. To make a syrup that will not granulate on standing and yet have body, the sap should be boiled down until the thermometer registers 219° F. Syrup thus made will weigh exactly 11 pounds to the gallon and will not grain on standing. If allowed to go above this it will grain. In practice the syrup is usually taken off just before it reaches 219° F.

When sugar is wanted the sap during the first and middle part of the season should be boiled until the thermometer registers 235° F. Maple sap contains some impurities, one of the more prominent of which is "nitre" or "sugar sand." This consists mostly of the malate of lime and greatly increases in quantity toward the end of the sugar season. The temperature then should be allowed to rise to 238° F. before the sugar is taken off. This should be done at any time if the syrup gets scorched or for any reason seems of poor quality. Maple sugar thus made will analyze 80 per cent of pure sugar.

When the buds begin to form the sap contains so many impurities that it cannot be boiled down sufficiently to make a good quality of sugar. At this season only syrup is made. The above temperatures presuppose that the maple syrup is allowed to cool and settle before it is made into sugar and that the sugar be stirred after it is taken off the fire until it grains. If this is not done the temperature should be 2° higher in each case for sugar. Milk or the white of eggs are sometimes added to syrup intended for sugar to clarify it; but if it is allowed to settle and then carefully drained off this will not be necessary.

Pure maple sugar is perfectly white and has the same sweetening value and chemical composition as granulated cane or beet sugar. The white sugar can be made by straining the sap or syrup through animal charcoal. This takes out all the coloring matter and also the peculiar flavor of the sugar which gives it its chief value. A gallon of good syrup weighing 11 pounds to the gallon will make 8¾ pounds of sugar testing 80 per cent pure—which is a very good sugar—or 7¾ pounds testing 90 per cent pure. These figures show that syrup at 75 cents per gallon is more profitable than sugar at 7 cents per pound. For further notes on maple sugar making see Vt. Expt. Sta. Buls. 26 and 103.

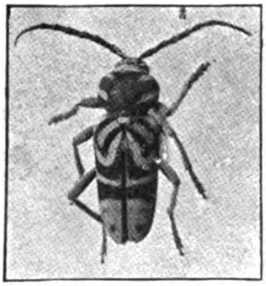

Fig. 473—MAPLE BORER
(After Felt)

Enemies: ANTHRACNOSE (*Gloeosporium apocryptum*) appears early in July as a discoloration and dying of the leaves on the terminal twigs. As a result of the death of the terminal shoots, a much branched head is developed and has to be pruned away. Pruning is perhaps less expensive than spraying with fungicides, of which 3 applications would be required. Maples are also attacked by leaf spot, but seldom to an injurious extent.

BORER (*Glycobius speciosus*) (Fig. 473) is a beetle 1 inch in length, with a yellow head, black thorax and 2 yellow spots on each side. The wing covers are black, ornamented with spots of yellow. The beetles appear in July or August, and lay their eggs in the bark. The grubs after hatching, burrow into the wood and cause considerable damage when occurring in large numbers. They may be cut out with a knife or destroyed by means of a wire. Badly infested trees should be cut down and burned.

FOREST TENT CATERPILLAR (*Clisiocampa disstria*) (Fig. 474) closely resembles the apple tree tent caterpillar, and may be combated in a similar manner. The species has for a number of years been exceedingly injurious to sugar maples, causing almost a complete defoliation of the trees. It is said that the sugar made from badly infested trees may be recognized by a peculiar flavor. The caterpillars collect in large masses on the trunks of trees and may be easily crushed in this position or sprayed with kerosene. Banding with tar paper, or raupenleim, will prevent the caterpillars from climbing up the trees. This species is preyed upon by a large variety of birds and is also subject to bacterial disease.

CECROPIA (*Platysamia cecropia*) is a very large and beautiful moth, belonging to the silkworm family, and feeding upon a number of trees, including the maple. The moth measures 5 or 6 inches across the wings, and is of a dusky brown color with yellow margins and large eye spots on each wing. The caterpillar when full grown is over 4 inches long, and bears 2 spiny tubercles on each joint, the tubercles being yellow and blue. The cocoon is large and conspicuous, being constructed of fine silken thread. The caterpillars and cocoons are so large that they are easily detected, and hand-picking is usually sufficient to hold them in check. Spraying with arsenicals may also be adopted.

BROWN TAIL MOTH (*Euproctis chrysorrhoea*) is pure white, with a few black dots on the forewings and a reddish-brown tuft at the end of the abdomen. The moth measures 1¼ inches across the wings. The eggs are laid in July in masses of 200 to 300 on the under side of the leaves. The larvae construct a tent in which they pass the winter. The color is pale brown and they are covered with reddish hairs. This insect has proved especially injurious to shade trees of various kinds in Massachusetts. It may be controlled by spraying with arsenate of lead.

WHITE MARKED TUSSOCK MOTH (*Notolophus leucostigma*) is a species of which the male has 4 wings, the front wings being crossed with dark bands and bearing a white spot on the inner edge. The general color is ash gray. The female resembles a caterpillar and possesses no wings. The eggs are laid in masses on the trees or in other situations. The head and 2 spots on the hind segments of the larva are bright red. The back is black, with 2 yellow lines, and the body is covered with long yellow hairs. There are 4 cream colored or white dense brushes of hair in a row along the middle of the back, and knobbed hairs on the head and hind segments of the larva. The egg masses may be easily detected and destroyed, or the infested trees may be sprayed with arsenate of lead.

FALL WEBWORM (*Hyphantria cunea*) is a pale yellow or green caterpillar, with a broad dusky stripe along the back and yellow stripes on the sides. They are covered with white hairs which arise from orange colored warts. The moth is white with a yellowish tint. The eggs are deposited in a cluster on the leaves. They are usually at the end of the branches. The caterpillars are frequently seen wandering about seeking hiding places for transformation, from August till the end of September. This species feeds on a large variety of shade trees and is often exceedingly injurious. It may be destroyed by spraying with arsenate of lead.

BAG WORM (*Thyridopteryx ephemeraeformis*) is recognized by the bags constructed by this insect, which are seen hanging on twigs of various trees in winter. The bags contain the shell of the chrysalis and numerous eggs. Eggs hatch in May and the caterpillars construct a case or bag in which they travel from branch to branch. The moth is black, with a hairy body. The female is naked and without wings or legs. This species feeds on a great variety of trees, including maple, red cedar and arbor vitae. The bags may be readily seen, collected and destroyed, or infested trees may be sprayed with arsenate of lead.

Besides these species, the maple is subject to the attacks of a large number of leaf-eating caterpillars which may be destroyed by spraying with arsenate of lead, and by a number of scale insects, for the treatment of which see under this subject.

MOSQUITOES

Mosquitoes are small 2-winged flies, with long slender abdomen, a fringe of hair around the edge of the wings, and scales on the wing veins. The larval state of many, if not all, species of mosquitoes is passed in stagnant water of pools or swamps. The eggs are laid on the surface of the water, singly or in masses, and the larvae are the well-known "wigglers" of rain barrels and pools. The larvae of some species remain for a greater portion of the time at the surface of the water and wriggle downward when frightened. Other species come to the surface only occasionally to breathe.

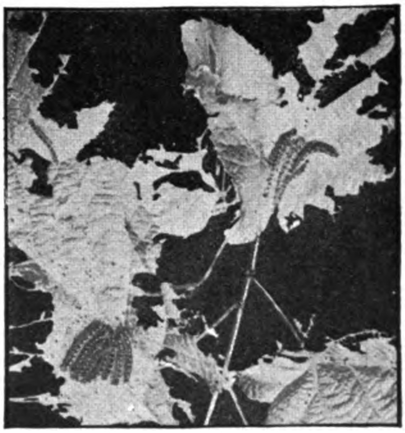

Fig. 474—FOREST TENT CATERPILLAR
(N. Y. State Expt. Sta.)

Mosquitoes pass the winter in the adult state in cellars and other protected places, and as larvae in water. There are several generations per year, depending upon the climate of the locality. Mosquito larvae die within a few days in wet mud, if the pond dries up. Their transportation from place to place is considerably facilitated by winds and by animals to which they become attached. The male lives but a short time and ordinarily does not suck blood. The female normally feeds on the juices of plants, but attacks warm-blooded animals at every opportunity. In some localities mosquitoes are so numerous as to become a plague and cause the interruption of business for a few weeks in summer.

The common means of preventing mosquitoes from entering houses is through screening of windows. In houses they may be destroyed by fumigating with pyrethrum, or they may be caught on the walls by the use of shallow cups containing a small quantity of kerosene and mounted on a pole. The most effective remedies are draining the marshes, or, where this is impossible, covering all stagnant water with a film of kerosene. For this purpose 1 ounce of kerosene is required for each 15 square feet of surface. The oil film should be renewed every 10 days during the season. The larvae on coming to the surface for air are killed by contact with the kerosene. Potassium permanganate is occasionally recommended in newspapers as a cheap and efficient remedy against mosquito larvae in water. Careful tests of this substance have shown that it is practically worthless.

Recently especial interest has been developed in mosquitoes on account of the demonstrated fact that mosquitoes are instrumental in carrying malaria to man. Malaria is transmitted to man through the bite of certain mosquitoes. Of the several genera of these insects, *Anopheles* is apparently the only one concerned. It is recommended that stagnant water in the neighborhood of cities should be treated with kerosene. Some authorities maintain that mosquitoes are also responsible for the transmission of yellow fever. This question is not definitely settled, but experiments in Cuba and elsewhere indicate that the disease may be controlled by destroying the mosquitoes.

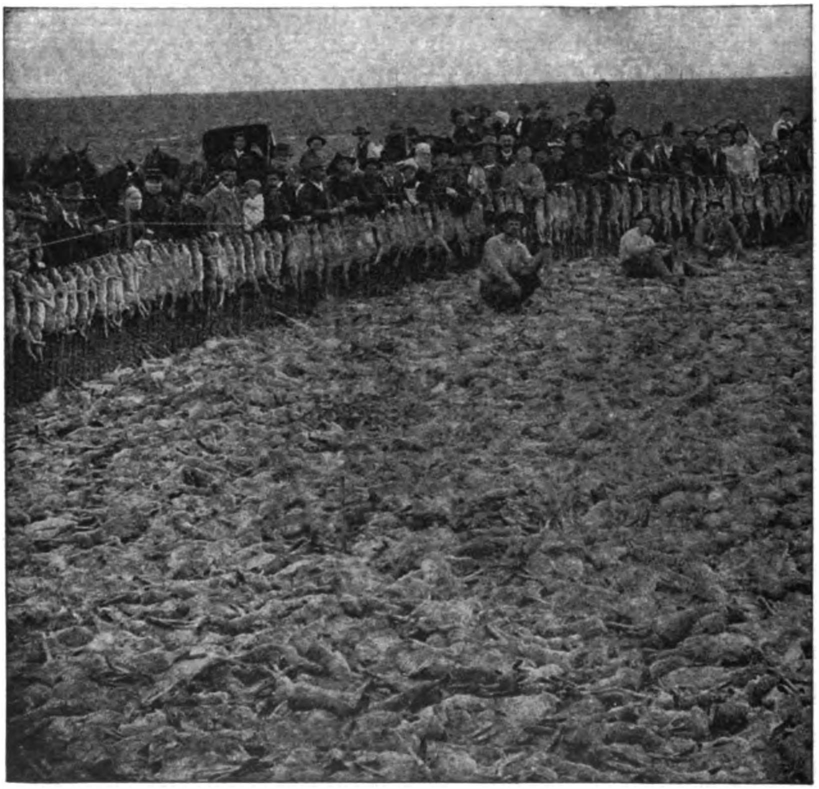

Fig. 475—RABBIT DRIVE IN THE WEST
(U. S. Dept. Agr.)

RABBITS

Considerable interest attaches at present to rabbits and hares especially on account of the great damage which they may commit upon cultivated crops, and on account of the profits which may be secured under favorable conditions from the breeding of some races, especially the Belgian hare. Rabbits and hares are universally hunted for game and their meat is generally considered a delicacy. In localities where the animals have bred in the wild state to such an extent as to become an agricultural nuisance they have been killed and their meat used in canning and for other purposes. Large shipments are annually made from Australia, where rabbits have perhaps become the most serious pests, and also from California, Colorado and other Western States, where the jack-rabbit has multiplied in large numbers.

Perhaps the most serious injury is done by rabbits in gnawing the bark of fruit trees in winter. When other food is scarce rabbits may destroy whole orchards by girdling the trees. Various methods have been adopted for the extermination of rabbits in such localities, and for the protection of fruit trees against their attacks. The methods employed for this purpose include hunting with firearms or with ferrets, trapping, asphyxiation with gases in their burrows and driving into corrals by means of regularly organized parties of mounted hunters, as seen in Fig. 475. The latter method has proved most successful in California, Oregon, Utah, Idaho and Colorado, where hundreds of thousands of jack-rabbits have been captured in this manner. As many as 20,000 have been captured in a single drive. The attempt to destroy rabbits by spreading contagious disease among them has thus far not proved very successful. The use of poisons, such as strychnin and phosphorus, has certain disadvantages, on account of the fact that the jack-rabbits do not burrow, and consequently the poisons must be scattered on the surface of the ground and be a source of danger to other animals. The protection of fruit trees and vineyards against rabbits may be accomplished by means of rabbit-proof fences made of woven wire, or by special cylinder protectors for each tree or grapevine. Young trees and grapevines may be protected by wrapping them with strips of burlap, gunny sacking, coarse cloth, wire netting, pasteboard, ordinary newspapers or by means of "tule-tree protector" or cylinders made of yucca wood. The last 2 named protectors are especially made for this purpose. Newspapers wrapped around the trees and fastened by a cord not too tightly serve as good protection against rabbits and mice. Some orchardists have been successful in protecting their trees against the attacks of rabbits by smearing the trunks near the ground with mixtures which are distasteful to rabbits.

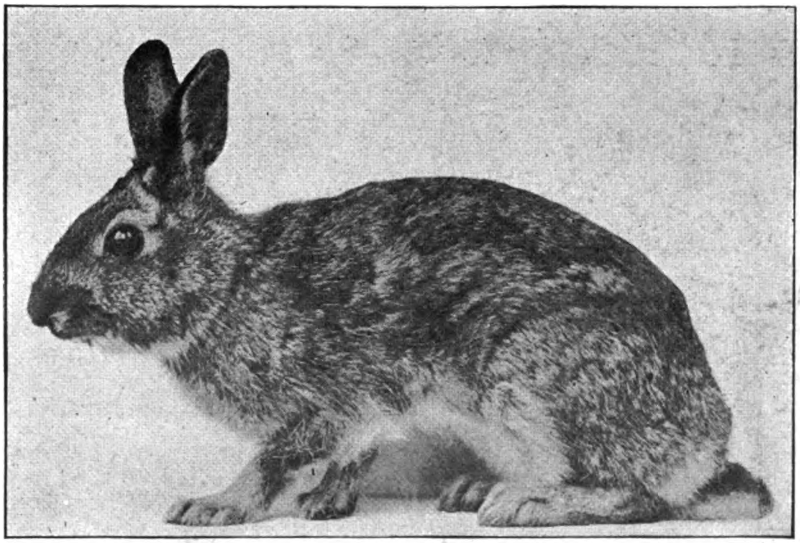

Fig. 476—THE COMMON WILD RABBIT
(From Ky. Expt. Sta. Bul. 93)

For this purpose whitewash, a mixture of glue and copperas, decoction of quassia chips and blood or grease, have been used. Mechanical protection by means of some wrapping is more permanent and effective than any form of wash.

The jack-rabbits of the Western States may be divided into 2 groups, in the first of which is placed the prairie hare, which turns white in winter and has no black on the tail. The second group includes jack-rabbits with a black stripe on the upper surface of the tail. A number of species have been described as belonging to the second group, and are distinguished by the general color of the body and marking of the ears. In the Eastern States the common rabbit is sometimes injurious to fruit trees, and orchards may be protected in the same way as recommended for jack-rabbits.

The natural enemies of rabbits help to prevent their increase in numbers. The most important of such enemies are hawks, owls, foxes, coyotes and weasels.

Belgian Hares—The Belgian hare has been claimed by some authorities to be a cross between the rabbit and hare. Mr. J. E. Harting asserts, however, that the Belgian hare or leporine is simply a large domesticated variety of the common rabbit, resembling the brown hare in form and color. The same authority states that this race of animals originated about 45 years ago in Belgium as a variety of the rabbit, and has since been reared extensively for the purpose of increasing its size and of producing the form, color and fur of the wild hare. The fur of the back next to the skin is dark colored, instead of being light, as in the case of the common brown hare. Their fore legs are much shorter than the latter. The standard of the Belgian hare's appearance, as adopted at present, requires that the color should be a rich reddish-brown, with as little white as possible under the jaws. The body should be long, with well tucked up flanks. The tail should be straight, the ears about 5 inches long and thin, the eye large and of a hazel color, the fore-feet and legs long and slender and free from white hairs. The weight should be about 8 pounds. The short, arched appearance of the back common in the rabbit is considered a defect in the Belgian hare. A common wild rabbit is seen in Fig. 476, and Belgian doe and her young in Fig. 477.

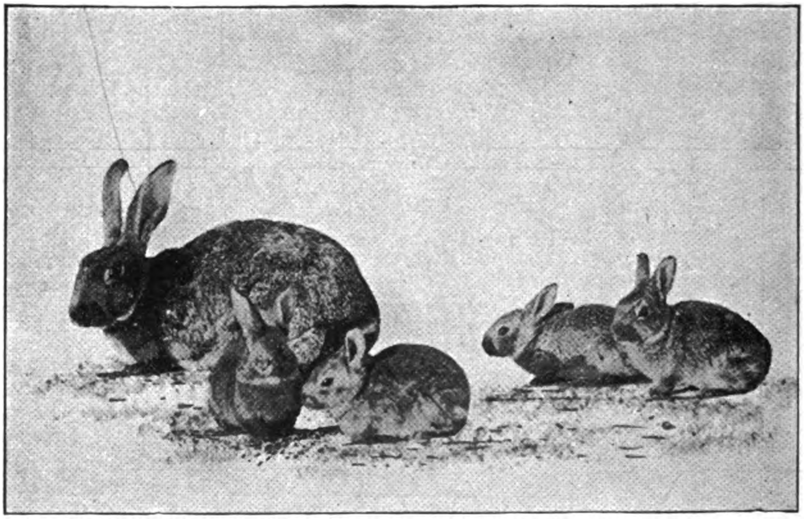

Fig. 477—BELGIAN DOE AND YOUNG
(R. I. Expt. Sta.)

Much interest has been recently developed in the breeding of these animals, and many persons in different parts of the country have gone into the business for profit. While good prices were obtained by special breeders for standard animals for breeding purposes, it must be admitted that there is no large natural demand for the meat of these animals, and persons who engage in this business with the expectation of making large profits are apt to be disappointed. The recent widespread interest, which was stimulated largely by Western breeders of the Belgian hare, is gradually dying out. The meat of these animals makes a savory dish when properly cooked, but the demand for it is not sufficiently great to warrant the unlimited production of these animals.

RATS

The common brown rat has become distributed throughout the civilized world by means of shipping and other methods of commercial transportation. The brown rat attacks all sorts of crops and grains, stored vegetable and animal products. It is also an enemy of poultry, and has been known to attack young pigs and lambs. Especial interest has lately been developed in the destruction of these animals, on account of their agency in distributing various infectious diseases. Their habit of eating any kind of decaying flesh or refuse makes it apparent that they may become one of the chief sources of spreading any contagious plague of man or animals. In the vicinity of slaughter houses they are not only a disgusting nuisance, but serve to spread the infestation of trichina. In some cities where they have become an intolerable nuisance, especially in European countries, they have been successfully combated by spreading among them contagious diseases which do not affect man or other animals. Besides this method for exterminating them, the use of traps of various designs, poisoned bait, hunting with ferrets and asphyxiation with bisulphid of carbon in the burrows have been employed with success. Similar methods of extermination have also been used with success in combating the common house mouse and field mice or voles.

SEEDS

Four rules of great importance in securing good seed have been laid down by writers on this subject. These are: (1) Buy only of reliable seedsmen, (2) buy the best grade of seed, (3) insist upon a statement of the percentage of seed which will germinate, and (4) test the seed yourself. Poor and cheap grades of seed are really more costly than the best and highest priced. According to actual tests unclean seed may contain 20,000,000 or more weed seed per bushel. Moreover, poor seed may contain such a small percentage of germinable seed that a thin stand of the crop is obtained. It may be necessary to buy 5 or 6 bushels of low grade seed in order to secure as much germinable seed as is contained in 1 bushel of good seed. The farmer will save time, money and labor by buying the best quality of seed. At the same time he will avoid seeding his farm to all kinds of weeds.

A guaranty of the quality of seed should be demanded from the seedsman, and their claims may easily be substantiated or disproved by a germination test. For this purpose a piece of blotting paper or flannel cloth may be moistened and folded together after placing a counted number, say 100, of the seed between the folds. The paper or cloth should then be laid on a plate, covered with another inverted plate and placed in a warm room. From 10 to 28 days should be allowed for the test, according to the kind of seed. The germinated seed may be counted and removed from day to day, and at the end of the test the percentage of good seed may be easily computed. The standard of germination adopted by the United States Department of Agriculture for clean seed, harvested and preserved under favorable conditions and not over 1 year old, is for a number of vegetables as follows: Beans, 90 per cent; beets, 142 plants from 100 seed balls; cabbage, 90 per cent; carrots, 80; cauliflower, 80; celery, 60; corn (flint and sugar), 87; cucumber, 87; eggplant, 80; leek, 80; lettuce, 85; muskmelon, 87; okra, 80; onion, 80; parsley, 70; parsnip, 70; peas, 93; peppers, 80; pumpkin, 87; radish, 90; spinach, 84; squash, 87; tomatoes, 85; turnips, 90; and watermelons, 87 per cent. These figures are based on results secured in a seed testing apparatus where the conditions of temperature and moisture could be controlled. When seed is tested in soil the germinations are likely to be 10 to 15 per cent lower than these figures.

As to relative value of new seed and those 2 years old or more, it may be stated in a general way that fresh seed give the best results, but there are some exceptions. Experienced cabbage growers claim that cabbage seed 2 to 3 years old make better and more solid heads than 1-year-old seed. Recent French experiments indicate that 2-year-old carrot seed gives less leafy plants and more highly colored roots. With pumpkins, squashes, melons and gherkins seed 2 to 3 years old proved most satisfactory.

Fresh seed produced too leafy a vegetation. Fresh radish seed was found preferable for culture out of doors; but under glass seed 2 to 3 years old was preferable since it gave a less leafy product.

Generally speaking the experiments indicated that fresh seed should be used when it is desired to produce plants with a strong leaf growth, while for plants which it is desired should head or fruit well, like cabbage, melons, cucumbers, etc., it is preferable to use seed 2 to 3 years old. Some ornamental plants tended to produce a larger proportion of double flowers when grown from 2-year-old seed than when grown from fresh seed.

TOADS

These animals, on account of their somewhat repulsive appearance, are persecuted to a considerable extent, and are often destroyed in large numbers by small boys. The toad, however, is a valuable friend to the greenhouse owner or gardener, and assists greatly in the destruction of common injurious insects in such localities. Their food consists almost exclusively of insects, slugs, worms and spiders. Insects constitute their chief element of diet, all sorts of insects, including beetles, cockroaches, plant bugs and caterpillars, being devoured greedily by the toad. It is desirable to protect all toads in the vicinity of gardens and in greenhouses. The most important natural enemies of toads are crows, hawks and owls. (Mass. Hatch Sta. Bul. 46.)

WEEDS

Any plants which grow in places where they are not wanted are weeds. Some weeds are of local distribution or only occasionally troublesome, while others are aggressive and occur everywhere. Lists of the worst weeds have been published in nearly every State, and they have been sufficiently described and illustrated. The only interest which the average individual has in weeds concerns the problem of how to eradicate them. The present brief discussion will be confined to the latter phase of the subject.

There is no royal road to the destruction of weeds. These plants thrive best in waste places, along roadsides and on poorly cultivated land. Where the soil is properly tilled and attention is given to a suitable rotation of crops, weeds are of little consequence. The possibility of a luxuriant growth of weeds simply furnishes an urgent reason for thorough tillage of the soil, and the result is seen in better crops of cultivated plants.

In gardens, cultivation and hand pulling are the sovereign remedies for weeds. In lawns, annual weeds may be destroyed by repeated mowing. Perennial weeds may be eradicated by digging and pulling and by sowing more and better grass seed. Weeds in grass lands are to be crowded out by securing a thick sod. If the grass seed is impure and the stand of grass is poor it may become necessary to plow and reseed. In cereal and other field crops the use of horse-power weeders has been attended with good results. Where a rational rotation of crops is followed, weeds seldom obtain a foothold. Special attention should always be given to waste places and roadsides in order to prevent weeds from going to seed in such localities. A number of States have passed laws making this compulsory. In many parts of the country, especially in the Western States, where grains volunteer very readily, summer fallowing is practiced, partly for the purpose of keeping down the weeds. If, however, the soil is not persistently cultivated, this practice simply gives the weeds an opportunity to develop unrestricted. Many weeds may be destroyed by repeated cutting before the seeds have become mature. If, for example, the oxeye daisy is cut within 10 days after blooming it will be prevented from reseeding.

Within the past few years quite extensive experiments have been made in Europe and this country in destroying weeds by means of chemicals. At the Rhode Island Station it was found that common sorrel could be gradually driven out of acid soils by liming. Lime increases the yield of timothy, orchard grass, brome grass or clover, but greatly checks the growth of sorrel. This may be accomplished by applying 5 tons of air-slaked lime per acre, followed by an application of 3 tons per acre during the next year. In North Dakota it was found that nearly all the annual weeds commonly found in grain fields could be killed by spraying with copper sulphate without injuring the grain. About 1 barrel (30 to 60 gallons) of a solution of copper sulphate in the proportion of 1 pound to 4 gallons of water is required per acre. This application is not effective in dry weather. Spraying should be done when the young weeds are just out of the ground, while the grain stands from 5 to 10 inches high. Experiments in Vermont showed that the various species of wild mustards could be cheaply destroyed in this manner. A number of other chemicals have been tested in spraying weeds, but usually without satisfactory results.

Crude carbolic acid, 1 pint in 4 gallons of water, is effective in destroying weeds in gravel walks, drives and similar places. Arseniate of soda (1 pound in 4 or 8 gallons of water) may also be used for the same purpose. Salt applied at the rate of 12 to 18 pounds per square rod, or 1 to 1½ tons per acre, will destroy the orange hawkweed, and may also be used to kill weeds in sidewalks. It should be applied dry, and in dry weather, by scattering broadcast in a uniform manner.

While it is true that these chemical methods for killing weeds give good results, the best way of handling weeds is by shorter rotation of crops and clean cultivation.

Weeds when turned under as a green manure furnish some humus to the soil. If eradicated by pulling, digging or mowing they may be fed to sheep, pigs and poultry.

Many weeds are of medicinal value and when properly cured and prepared may be sold as drugs. For this purpose the roots, stems, leaves, flowers or seeds of various plants are used. Roots should be collected in a mature condition, or just before flowering in the case of annuals and in autumn with perennials. Leaves and flowers should be collected when the plants are in full bloom. All plant parts collected for drugs should be cleaned and dried, preferably in the shade. The market demands and prices for such native drugs may be learned through the nearest drug store.

Physicians have largely abandoned the use of most of these drugs on account of a lack of certainty or uniformity in their action. Some of them, however, possess well-known active principles. In this class we may mention hellebore, foxglove, aconite, larkspur, mustard, stramonium and poison hemlock. Many other weeds are popularly believed to possess certain medicinal properties, being extensively used as tonics, vermifuges, "blood purifiers," etc. In this class we may place burdock, dandelion, docks, pokeweed, mullein, gum plant, boneset, catnip, yarrow, flea-bane, lobelia, tansy, hoarhound, pennyroyal, wild cherry bark, wild sarsaparilla, sassafras, elder, etc. All farmers are familiar with the use of these weeds in the preparation of medicines for home use. Under favorable conditions they may also become the source of some profit.

For descriptions of various weeds and notes on their eradication and medicinal utilization consult U. S. Dept. Agr. Farmers' Buls. 28 and 188; Rpt. N. D. Expt. Sta. for 1900, p. 48; Rpt. Vt. Expt. Sta. for 1900, p. 282, and Iowa Expt. Sta. Bul. 70. (See also *Plants Poisonous to Stock.*)

APPENDIX

PERCENTAGE COMPOSITION OF FEEDING STUFFS*

AVERAGES OF MANY ANALYSES

	Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
Acorns, fresh	55.3	1.0	2.5	4.4	34.8	1.9
Alfalfa, green fodder	71.8	2.7	4.8	7.4	12.3	1.0
Hay	8.4	7.4	14.3	25.0	42.7	2.2
Apples, fresh	80.8	0.4	0.7	1.2	16.6	0.4
Artichokes (Jerusalem), tubers	78.0	1.8	2.4	0.9	16.8	0.1
Barley, hay	10.6	5.3	9.3	23.6	48.7	2.5
Grain	10.9	2.4	12.4	2.7	69.8	1.8
Malt sprouts	10.2	5.7	23.2	10.7	48.5	1.7
Brewers' grains, wet	75.7	1.0	5.4	3.8	12.5	1.6
Brewers' grains, dry	8.0	3.4	24.1	13.0	44.8	6.7
Screenings	12.2	3.6	12.3	7.3	61.8	2.8
Meal	11.9	2.6	10.5	6.5	66.3	2.2
Straw	8.3	3.8	3.7	42.0	39.5	2.7
Beans, Adzuki	15.8	3.5	20.6	3.9	55.5	0.7
†Cull field	10.0	3.2	21.6	3.7	47.5	1.2
Horse, fresh	84.2	1.2	2.8	4.8	6.5	0.4
Navy	12.6	3.5	22.5	—	59.7	1.9
Beets, red	88.5	1.0	1.5	0.9	8.0	0.1
Beggarweed, hay	9.2	4.7	11.8	29.1	42.1	2.9
Bermuda grass, in bloom	71.7	2.0	2.1	5.9	17.3	0.9
Blue joint, hay	6.8	5.3	9.5	33.8	42.2	2.4
Brome grass, in head	64.1	3.0	4.0	10.9	16.2	1.8
Hay	11.0	9.5	11.6	30.8	35.2	1.8
Broom corn, hay	9.4	5.7	3.9	36.8	42.4	1.8
Buckwheat, straw	9.9	5.5	5.2	43.0	35.1	1.3
Bran	11.5	4.5	24.8	11.7	40.8	6.7
Middlings	11.8	4.8	28.0	6.3	41.9	7.2
Grain	12.6	2.0	10.0	8.7	64.5	2.2
Cabbage	90.5	1.4	2.4	1.5	3.8	0.4
Carrot, root	88.6	1.0	1.1	1.3	7.6	0.4
Cassava	66.6	0.7	0.8	1.6	29.8	0.2
Chicken corn forage	73.0	1.9	2.4	9.0	11.0	0.8
Clover, hay (red)	20.8	6.6	12.4	21.9	33.8	4.5
Silage (red)	72.0	2.6	4.2	8.4	11.6	1.2
Green (red)	70.8	2.1	4.4	8.1	13.5	1.1
Alsike, green	74.8	2.0	3.9	7.4	11.0	0.9
Alsike, hay	9.7	8.3	12.8	25.6	40.7	2.9
Crimson, green	80.9	1.7	3.1	5.2	8.4	0.7
Crimson, hay	9.6	8.6	15.2	27.2	36.6	2.8
Corn, grain	10.9	1.5	10.5	2.1	69.6	5.4
Meal	15.0	1.4	9.2	1.9	68.7	3.8
Bran	8.7	1.5	9.8	11.2	62.6	6.2
Cob	10.7	1.4	2.4	30.1	54.9	0.5
Meal and cob	15.1	1.5	8.5	6.6	64.8	3.5
Germ	10.7	4.0	9.8	4.1	64.0	7.4
Gluten meal (Buffalo)	8.2	0.9	24.5	6.1	47.8	12.5
Gluten meal, miscellaneous	8.6	0.8	30.0	2.6	49.2	8.8
Cream gluten	9.6	0.9	34.6	1.9	50.4	2.6
Gluten feed	8.1	1.3	32.2	6.4	54.7	6.3
Distillery grains, dried	7.0	2.0	29.2	11.0	39.4	11.4
Corn fodder, green, flint	79.8	1.1	2.0	4.3	12.1	0.7
Green, dent	79.0	1.2	1.7	5.6	12.0	0.5
Green, sweet	79.1	1.3	1.9	4.4	12.8	0.5
Leaves and husks, green	66.2	2.9	2.1	8.7	19.0	1.1

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* Adapted from the United States Department of Agriculture Farmers' Bulletin 22 and other sources.

† Refuse, mostly gravel, 12.8 per cent.

	Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
Corn fodder, dry	42.2	2.7	4.5	14.3	34.7	1.6
Leaves, dry	30.0	5.5	6.0	21.4	35.7	1.4
Husks, dry	50.9	1.8	2.5	15.8	28.3	0.7
Stover, dry	40.5	3.4	3.8	19.7	31.5	1.1
Silage	74.4	1.5	2.2	5.8	15.0	1.1
Cottonseed, whole	9.1	4.0	19.6	18.9	28.3	20.1
Meal	8.2	7.2	42.3	5.6	23.6	13.1
Hulls	11.1	2.8	4.2	46.3	33.4	2.2
Feed (meal and hulls, 1 to 4)	8.0	3.7	13.4	32.5	38.7	3.7
Cowpea, green vines	83.6	1.7	2.4	4.8	7.1	0.4
Silage	79.3	2.9	2.7	6.0	7.6	1.5
Hay	10.7	7.5	16.6	20.1	42.2	2.9
Grain	11.9	3.4	23.5	3.8	55.7	1.7
Crab grass, hay	10.3	7.3	6.9	32.9	41.0	1.6
Durra, grain	10.3	5.7	4.4	33.4	44.4	1.8
Egyptian corn, grain	8.2	1.8	13.1	1.6	70.5	4.8
Leaves	6.1	11.8	10.1	23.8	46.4	1.7
Stalk	6.0	7.5	3.7	31.6	47.8	3.4
Flat pea, green	66.7	2.9	8.7	7.9	12.2	1.6
Hay	8.4	7.9	22.9	26.2	31.4	3.2
Johnson grass, hay	10.2	6.1	7.2	28.5	45.9	2.1
Kafir corn, grain	12.5	1.3	10.9	1.9	70.5	2.9
Stover	19.2	8.0	4.8	26.8	39.6	1.6
Green	73.0	2.0	2.3	6.9	15.1	0.7
Kentucky bluegrass	49.4	3.9	5.2	15.4	24.9	1.3
Hay	9.4	7.7	10.4	19.6	50.4	2.5
Lespedeza, hay	11.0	8.5	13.8	24.0	39.0	3.7
Linseed meal, old process	9.2	5.7	32.9	8.9	35.4	7.9
New process	3.9	5.6	35.9	8.8	36.8	3.0
Mangel wurzels	91.2	1.0	1.4	0.8	5.4	0.2
Meadow fescue, hay	20.0	6.8	7.0	25.9	38.4	2.7
Green	69.9	1.8	2.4	10.8	14.3	0.8
Millet, Japanese, green	75.0	1.5	2.1	7.8	13.1	0.5
Hungarian, hay	7.7	6.0	7.5	27.7	49.0	2.1
Hungarian, green	71.1	1.7	3.1	9.2	14.2	6.7
Hungarian, seed	14.0	3.3	11.8	9.5	57.4	4.0
Milo maize, white, mature head	15.7	1.7	8.2	8.4	63.1	2.8
Oats, grain	11.0	3.0	11.8	9.5	59.7	5.0
Feed	7.7	3.7	16.0	16.1	59.4	7.1
Straw	9.2	5.1	4.0	37.0	42.4	2.3
Hay	16.0	6.1	7.4	27.2	40.6	2.7
Green fodder	62.2	2.5	3.4	11.2	19.3	1.4
Orchard grass, in bloom	73.0	2.0	2.6	8.2	13.3	0.9
Hay	9.9	6.0	8.1	32.4	41.0	2.6
Parsnips	88.3	0.7	1.6	1.0	10.2	0.2
Pea, meal	10.5	2.6	20.2	14.4	51.1	1.2
Silage	50.1	3.5	5.9	13.0	26.0	1.6
Peas, Canada field	15.0	2.4	23.7	7.9	50.2	0.8
Peanut vine, hay	7.6	10.8	10.7	23.6	42.7	4.6
Kernels	7.5	2.4	27.9	7.0	15.6	39.6
Meal	10.7	4.9	47.6	5.1	23.7	8.0
Hulls	9.0	3.4	6.6	64.3	15.1	1.6
Perennial rye grass, hay	14.0	7.9	10.1	25.4	40.5	2.1
Potato tubers	78.9	1.0	2.1	0.6	17.3	0.1
Prickly comfrey, green	88.4	2.2	2.4	1.6	5.1	0.3
Pumpkins	90.9	0.5	1.3	1.7	5.2	0.4
Rape, green	85.7	2.0	2.4	2.2	7.1	0.6
Redtop, hay	8.9	5.2	7.9	28.6	47.5	1.9
Grass	56.6	2.9	3.8	11.7	23.9	1.0
Rhode Island bent grass, hay	7.1	6.7	6.1	31.9	46.3	1.9
Rice, grain	12.4	0.4	7.4	0.2	79.2	0.4
Bran	9.7	10.0	12.1	9.5	49.9	8.8
Hulls	8.2	13.2	3.6	35.7	38.6	0.7
Polish	10.0	6.7	11.7	6.3	58.0	7.3
Rutabagas	88.6	1.2	1.2	1.3	7.5	0.2
Rye, grain	11.6	1.9	10.6	1.7	72.5	1.7
Flour	13.1	0.7	6.7	0.4	78.3	0.8
Green fodder	76.6	1.8	2.6	11.6	6.8	0.6
Straw	7.1	3.2	3.0	38.9	46.6	1.2
Rye grass (Italian), hay	8.5	6.9	7.5	30.5	45.0	1.7
In bloom	73.2	2.5	3.1	6.8	13.3	1.3
Sainfoin, hay	15.0	7.3	14.4	20.4	39.5	3.0

	Water	Ash	Protein	Fiber	Nitrogen free extract	Fat
Saltbush, Australian, green	78.0	4.6	2.7	3.7	10.4	0.5
Hay	7.0	19.4	11.6	15.9	44.0	2.0
Salt marsh, hay	10.4	7.7	5.5	30.0	44.1	2.4
Serradella, hay	9.2	7.2	15.2	21.6	44.2	2.6
Green	79.5	3.2	2.7	5.4	8.6	0.7
Sorghum, seed	12.8	2.1	9.1	2.6	69.8	3.6
Silage	76.1	1.1	0.8	6.4	15.3	0.3
Green fodder	79.4	1.1	1.3	6.1	11.6	0.5
Soy bean, seed	8.7	5.4	36.3	3.9	27.7	18.0
Silage	74.2	2.8	4.1	9.7	6.9	2.2
Green	75.1	2.6	4.0	6.7	10.6	1.0
Hay	11.3	7.2	15.4	22.3	38.6	5.2
Spurry, green	75.7	4.0	2.0	4.9	12.7	0.8
Squashes, whole fruit	94.9	0.4	0.7	0.5	3.2	0.3
Sugar beet, root	86.7	0.8	1.5	0.9	9.9	0.1
Pulp, fresh	89.9	0.4	1.0	2.2	6.3	0.2
Pulp, dry	6.4	3.3	10.8	19.8	58.4	1.3
Sunflower seed	8.6	2.6	16.3	29.9	21.4	21.2
Stalks and leaves	84.4	1.9	1.0	5.7	6.1	0.9
Heads with seed	75.6	1.3	2.3	7.9	7.8	4.9
Sweet potato, tuber	71.1	1.0	1.5	1.3	24.7	0.4
Vines	41.5	5.8	7.7	13.6	29.3	2.1
Sweet corn, cobs	80.1	0.6	1.3	5.6	11.8	0.5
Husks	86.2	0.6	1.1	3.5	8.4	0.2
Kernels	82.1	0.6	2.9	0.5	12.9	0.9
Stalks	80.9	1.2	1.7	0.4	15.4	0.4
Tall oat grass, green	69.5	2.0	2.4	9.4	15.8	0.9
Teosinte, green	79.8	1.3	0.9	6.2	11.5	0.3
Timothy, green	61.6	2.1	3.1	11.8	20.2	1.2
Hay	15.0	4.5	6.0	29.6	41.9	3.0
Turnips, roots	90.6	0.8	1.3	1.2	5.9	0.2
Velvet beans, grain	11.5	3.2	22.7	7.6	48.5	6.6
Hay	10.0	5.9	14.0	37.7	30.6	1.8
Vetch, hay	11.3	7.9	17.0	25.4	36.1	2.3
Wheat, grain (spring)	10.4	1.9	12.5	1.8	71.2	2.2
Grain (winter)	10.5	1.8	11.8	1.8	72.0	2.1
Bran	11.9	5.8	15.4	9.0	53.9	4.0
Middlings	12.1	3.3	15.6	4.6	60.4	4.0
Screenings	11.6	2.9	12.5	4.9	65.1	3.0
Shorts	11.8	4.6	14.9	7.4	56.8	4.5
Straw	9.6	4.2	3.4	38.1	43.4	1.3
Wild oat grass, hay	14.3	3.8	5.0	25.0	48.8	3.3

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